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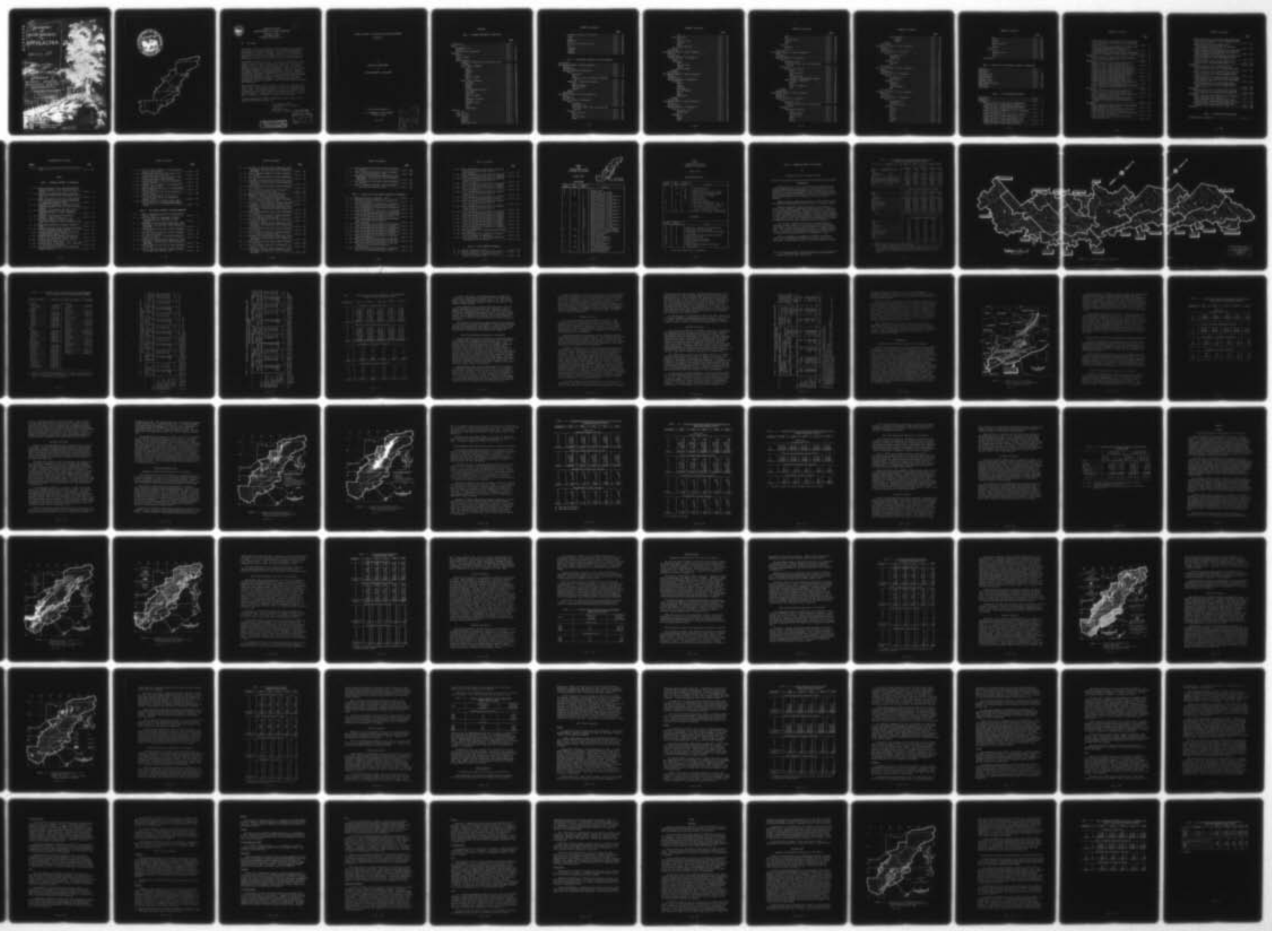

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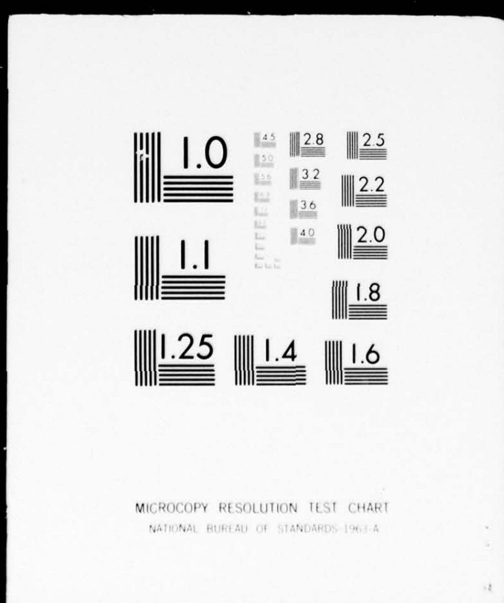

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Development of WATER RESOURCES in APPALACHIA.

Volume 24.

APPENDIX I.

MINERAL INDUSTRY- and RESOURCES & WATER REQUIREMENTS.

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U.S. DEPARTMENT OF INTERIOR
BUREAU OF MINES

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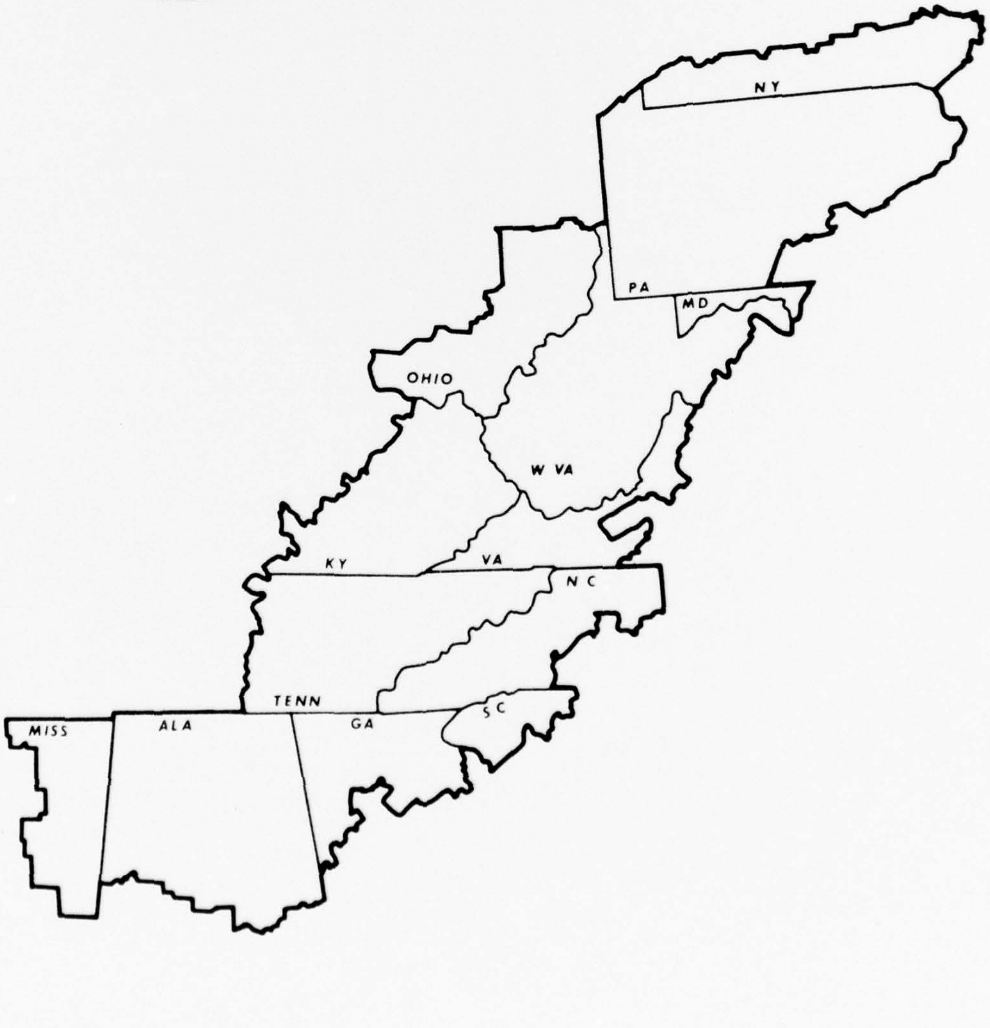

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF MINES
4800 FORBES AVENUE
PITTSBURGH, PENNSYLVANIA 15213

(1)

TO: THE READER

The Bureau of Mines, as an agency of the Department of the Interior, participated in the study authorized by the Appalachian Regional Development Act of 1965, as amended. Appendix I has been prepared by the Bureau of Mines in cooperation with the U.S. Army Corps of Engineers to provide mineral-related information needed to plan the development and use of water and related resources in Appalachia.

The Appendix contains five parts. The geologic distribution, availability, and importance of mineral commodities in the Region is discussed in Part 1. - Mineral Resources in Appalachia. The mineral industry of each of the 10 water subregions is described in Part 2. - The Mineral Industry in the Water Subregions. Part 3. - Water Use by the Mineral Industry in Appalachia summarizes quantities, sources, availability, and quality requirements of water used for mineral production and preparation. Part 4. - Site Examination Reports consists of individual reports describing the probable effect of mineral resources and the mineral industry on selected sites where water development projects are proposed. Part 5 contains a brief discussion and conclusions.

This Appendix supports the main report, which is also organized into Parts. Part I is the Summary Report which should be consulted for an overall view of the Appalachian Region. Part II is composed of pairs of chapters providing more definitive information on each of the 10 water subregions. A volume index of the report components is in the Table of Contents for Appendix I on pages I-xvi and I-xvii.

For any explanation or further information on the contents of this Appendix please address request to:

U. S. Bureau of Mines
Pittsburgh Office of Mineral
Resources
4800 Forbes Avenue
Pittsburgh, PA 15213

MINERAL INDUSTRY - RESOURCES AND WATER REQUIREMENTS

APPENDIX I

To

REPORT FOR DEVELOPMENT

of

WATER RESOURCES IN APPALACHIA

Prepared and Printed by:

U. S. DEPARTMENT OF THE INTERIOR
Bureau of Mines

May 1969

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PART 4. - SITE EXAMINATION REPORTS

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ILLUSTRATIONS (continued)

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TABLES (continued)

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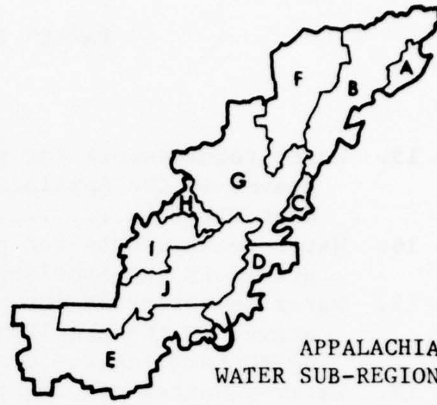
REPORT
FOR
DEVELOPMENT OF WATER
RESOURCES IN APPALACHIA

VOLUME INDEX



APPALACHIAN
WATER SUB-REGIONS

MAIN REPORT

Volume Number	Part Number	Chapter Number	Contents
1	I	-	Summary Report
2	I	-	Key Map Folio (By States)
3	II	1	Water Sub-Region A Today
		2	Shaping the Plan for Sub-Region A
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		4	Shaping the Plan for Sub-Region B
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		6	Shaping the Plan for Sub-Region C
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7	III	5	Clinchfield Reservoir
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		10	Stannard Reservoir
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		12	Greenbrier Reservoirs
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REPORT
FOR
DEVELOPMENT OF WATER
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		19	Otocsin (Pa.)
		20	Naturealm (Pa.)
12	IV	-	Concepts & Methods
13	V	-	State Water Supplements: Ala., Ga., Ky., Md., Miss., N.Y., N.Car.
14	V	-	State Water Supplements: O., Pa., S.Car., Tenn., Va., W.Va.
15	VI	-	History, Coordination & Cooperation

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16	A	Agriculture, Forestry and Conservation
17	B	Power Supply and Requirements
18	C	Prevention of Water Pollution by Drainage from Mines
19	D	Water Supply and Water Pollution Control
20	E	Economic Base Study
21	F	Recreation and Aesthetics
22	G	Fish and Wildlife Resources
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PART 1. - MINERAL RESOURCES IN APPALACHIA

by

The Staff of the U.S. Bureau of Mines

INTRODUCTION

Appalachia (fig. 1 - 1) is rich in mineral resources and many mineral commodities have been produced in the Region (table 1 - 1). Production of fossil fuels--bituminous coal, anthracite, petroleum, and natural gas--has been Appalachia's most important mineral contribution to the economy of the Region. Nationally, bituminous coal produced in Appalachia has been a leading factor in the growth of industry.

Values of mineral commodities expressed in 1958 constant dollars were computed using deflators developed by the U.S. Bureau of Mines.

Among the nonmetallic mineral commodities, stone, sand and gravel, clays, cement, and lime have accounted for most of the value of nonfuel mineral production. Substantial reserves of bituminous coal and the nonmetallic mineral commodities remain and are available to support industrial and urban expansion. With the notable exception of zinc, metal ores have not been produced in significant quantities, but many metals such as iron, aluminum, and ferroalloys are processed in Appalachia from ores and concentrates produced elsewhere.

The following condensed description of Appalachian mineral resources is based largely on U.S. Geological Survey Professional Paper 580,[1/] to which the U.S. Bureau of Mines was a major contributor. Time limitations prevented modification of commodity maps and data to include the counties added to Appalachia in October 1967 by the Appalachian Regional Development Act Amendments of 1967.

Part 1 of Appendix I was prepared principally by Richard J. Leary. Other contributors were Robert G. Clarke, James R. Kerr (deceased), Joseph Krickich, David J. Kusler, and Lawrence Y. Marks.

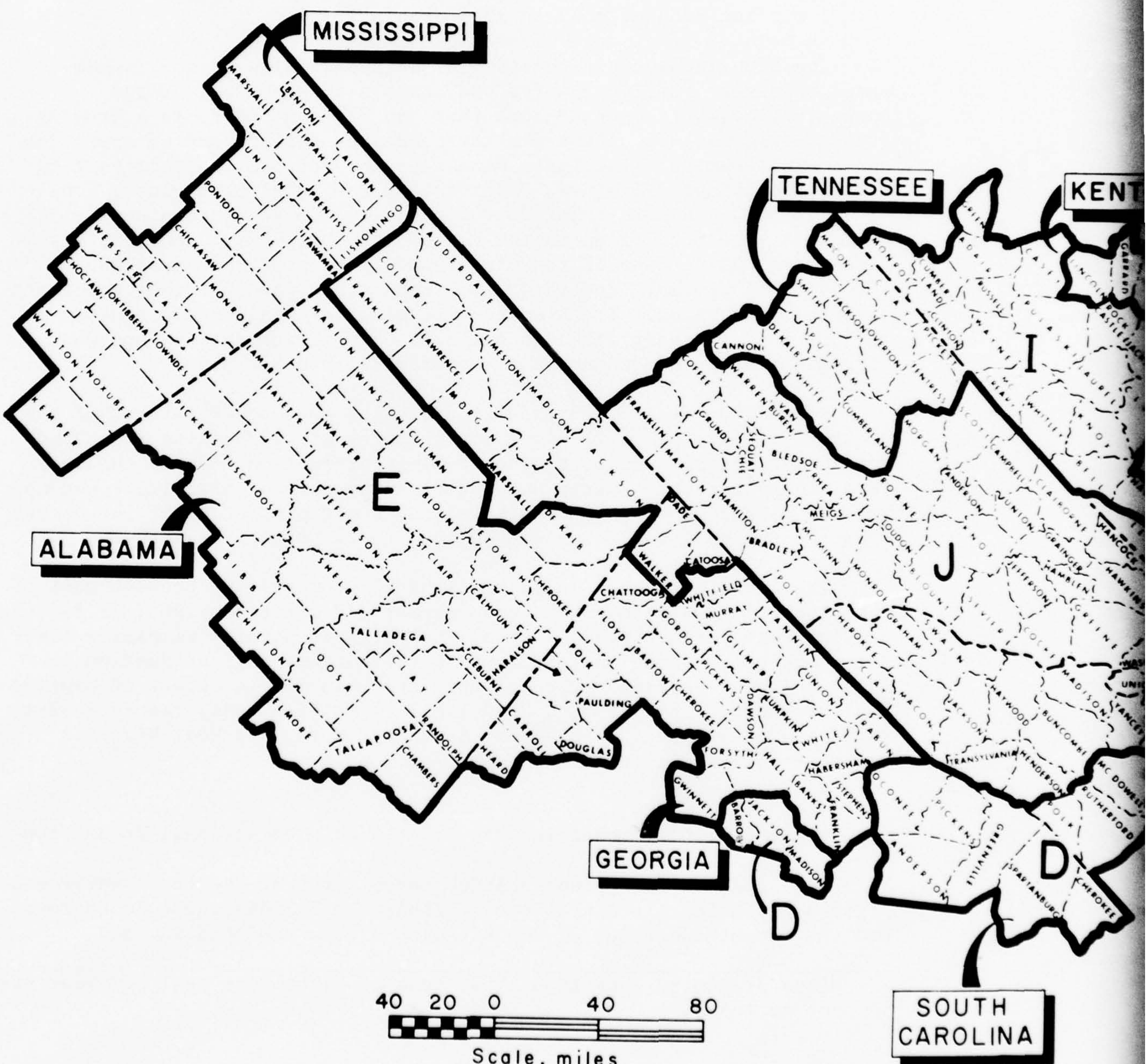
1/ U. S. Geological Survey. Mineral Resources of the Appalachian Region Prof. Paper 580, 1968, 492 pp.

TABLE 1 - 1. - Mineral production, value, and distribution of value by minerals in the Appalachian Region, 1961-65

Mineral	1961	1962	1963	1964	1965
	Production				
Cement........thousand 376-lb. bbl......	40,615	41,457	41,404	44,069	47,024
Clay.........thousand short tons.......	7,993	7,562	7,869	8,152	8,932
Coal:					
Anthracite............do............	16,657	16,094	17,355	16,265	14,009
Bituminous............do............	287,021	301,498	329,696	350,513	368,808
Lime...................do............	1,910	1,782	1,934	2,273	2,510
Natural gas......million cubic feet.....	405,113	391,840	393,563	373,058	381,410
Natural gas liquids..thousand gallon....	644,442	618,337	594,998	586,565	594,905
Petroleum (crude).thousand 42-gal. bbl..	17,589	17,551	17,347	18,461	17,784
Sand and gravel...thousand short tons...	26,880	29,481	29,624	31,053	35,391
Stone..................do............	77,016	83,167	88,524	91,892	97,852
Zinc.............short tons...........	104,320	91,762	116,711	136,947	142,878
	Value (thousand 1958 constant dollars)1/				
Cement................................	132,200	134,462	132,663	139,853	148,804
Clay..................................	25,815	22,690	25,252	26,581	30,382
Coal:					
Anthracite...........................	146,832	142,854	165,692	158,386	130,115
Bituminous...........................	1,473,618	1,553,084	1,687,062	1,797,647	1,899,626
Lime..................................	23,445	22,651	24,089	28,279	31,888
Natural gas...........................	110,564	103,925	100,793	94,634	92,441
Natural gas liquids...................	33,853	30,075	29,402	28,161	27,996
Petroleum (crude).....................	68,386	66,115	65,277	67,127	63,961
Sand and gravel.......................	41,264	45,225	46,827	48,817	55,439
Stone.................................	136,862	147,358	155,808	163,195	178,535
Zinc..................................	21,232	18,541	23,502	29,836	30,624
Other2/...............................	61,636	58,677	47,911	48,273	50,545
Total.............................	2,275,707	2,345,657	2,504,278	2,630,789	2,740,356
	Distribution of value (percent)				
Cement................................	5.8	5.7	5.3	5.3	5.4
Clay..................................	1.1	1.0	1.0	1.0	1.1
Coal:					
Anthracite...........................	6.4	6.1	6.6	6.0	4.8
Bituminous...........................	64.8	66.2	67.3	68.3	69.3
Lime..................................	1.0	1.0	1.0	1.1	1.2
Natural gas...........................	4.9	4.4	4.0	3.6	3.4
Natural gas liquids...................	1.5	1.2	1.2	1.1	1.0
Petroleum (crude).....................	3.0	2.8	2.6	2.6	2.3
Sand and gravel.......................	1.8	1.9	1.9	1.9	2.0
Stone.................................	6.0	6.2	6.2	6.2	6.5
Zinc..................................	1.0	1.0	1.0	1.1	1.1
Other2/...............................	2.7	2.5	1.9	1.8	1.9
Total.............................	100.0	100.0	100.0	100.0	100.0

1/ Deflators were developed by the U.S. Bureau of Mines.

2/ Includes abrasives, asbestos, asphalt, barite, bauxite, bromine (1961), calcium magnesium chloride, copper, feldspar, gem stones, gold, gypsum, ilmenite (1961-62), iron ore, iron oxide pigments, lead, magnesium compounds (1962), manganiferous ore (1961-62), mica, olivine, peat, potassium salts, pyrites, salt, silver, talc, tripoli, and vermiculite (1961-62).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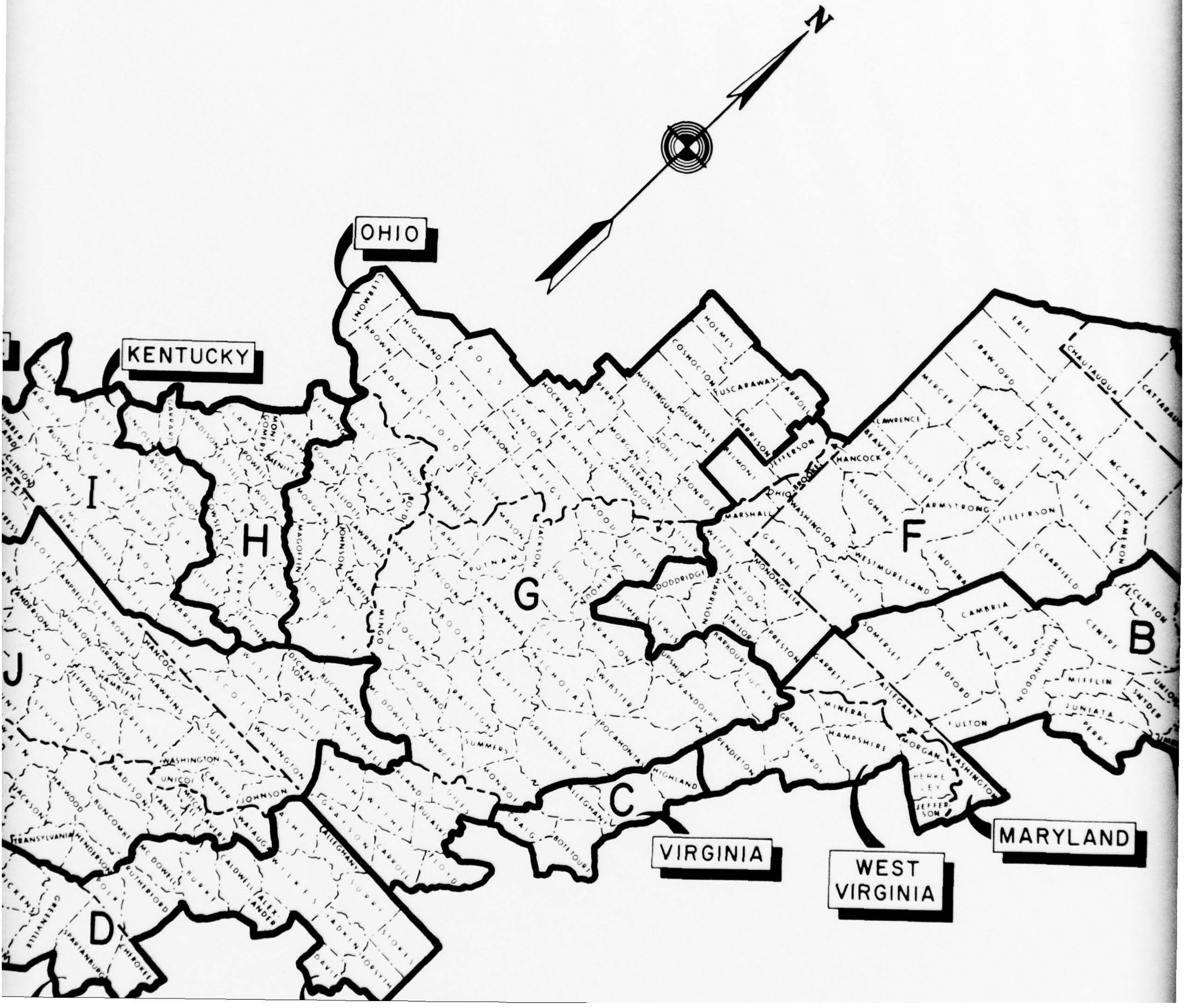

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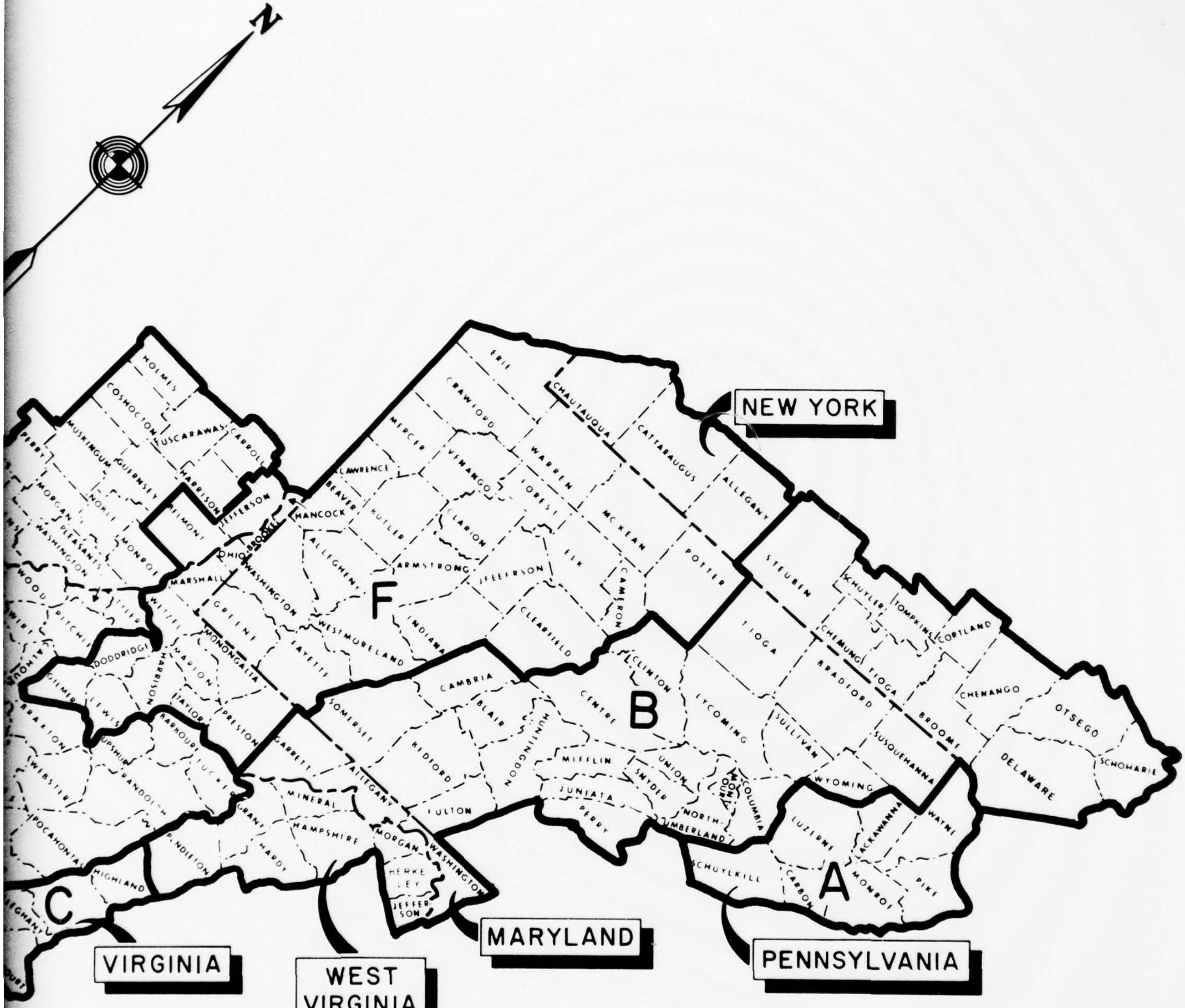

COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION
APPENDIX I MINERAL RESOURCES
prepared by
U. S. Department of the Interior
Bureau of Mines

lachia.

FUELS

Bituminous Coal

Geographic Distribution and Structure of the Industry

Bituminous coal in the Appalachian Region (fig. 1 - 2) underlays an area of 72,000 sq. mi. in parts of nine States. In 1965, about 6,646 underground and surface mines[2/] were in operation in 151 of the 397 Appalachian counties. Of these 151 counties, 57 produced more than 1 million tons of coal in 1965 (table 1 - 2).

The bituminous coal industry in the Appalachian Region is composed mainly of small companies operating a single mine. Large companies, however, operate more than one mine and there is a growing trend toward mergers of the smaller companies for economy of operation and administration. The large mines account for the greatest part in total production; 195 mines, 3 percent of the total mine count, individually produced more than 500,000 tons in 1965 and accounted for 52 percent of the production in the Region (table 1 - 3). However, 3,401 mines, over 50 percent of the mine count, each produced less than 10,000 tons per year, and their combined output was less than 4 percent of total production. The average-size mine in Appalachia produced 55,500 tons per year; although Alabama, Ohio, Pennsylvania, and West Virginia mines produced above the average (table 1 - 3).

Production from 5,023 underground mines made up 76 percent of the Region's output (table 1 - 4). Strip mining at 1,230 sites accounted for 20 percent of output, and auger-mined production made up the remaining 4 percent. Strip and auger mining have progressively become more widespread and important increasing their proportion of the output from the region from 10 percent in 1955 to 24 percent in 1965.

The bituminous coal industry is highly competitive because most of the production is sold on the open market. However, in 1965, 71.8 million tons was produced by steel and electric utility companies for their own use. About one-fifth of the bituminous coal production in Appalachia was captive. Pennsylvania and Ohio led in output of captive coal production in 1965 with 31.0 and 19.7 million tons, respectively; captive coal produced in Alabama, Kentucky, Ohio, and West Virginia was more than 5 million tons each.

Current Regional Production and Relationship to National Production

The Appalachian Region includes seven Corps of Engineers water subregions producing bituminous coal. Table 1 - 5 lists these Subregions and the output and value of the bituminous coal produced in each.

2/ Mines producing less than 1,000 tons of bituminous coal per year are not included.

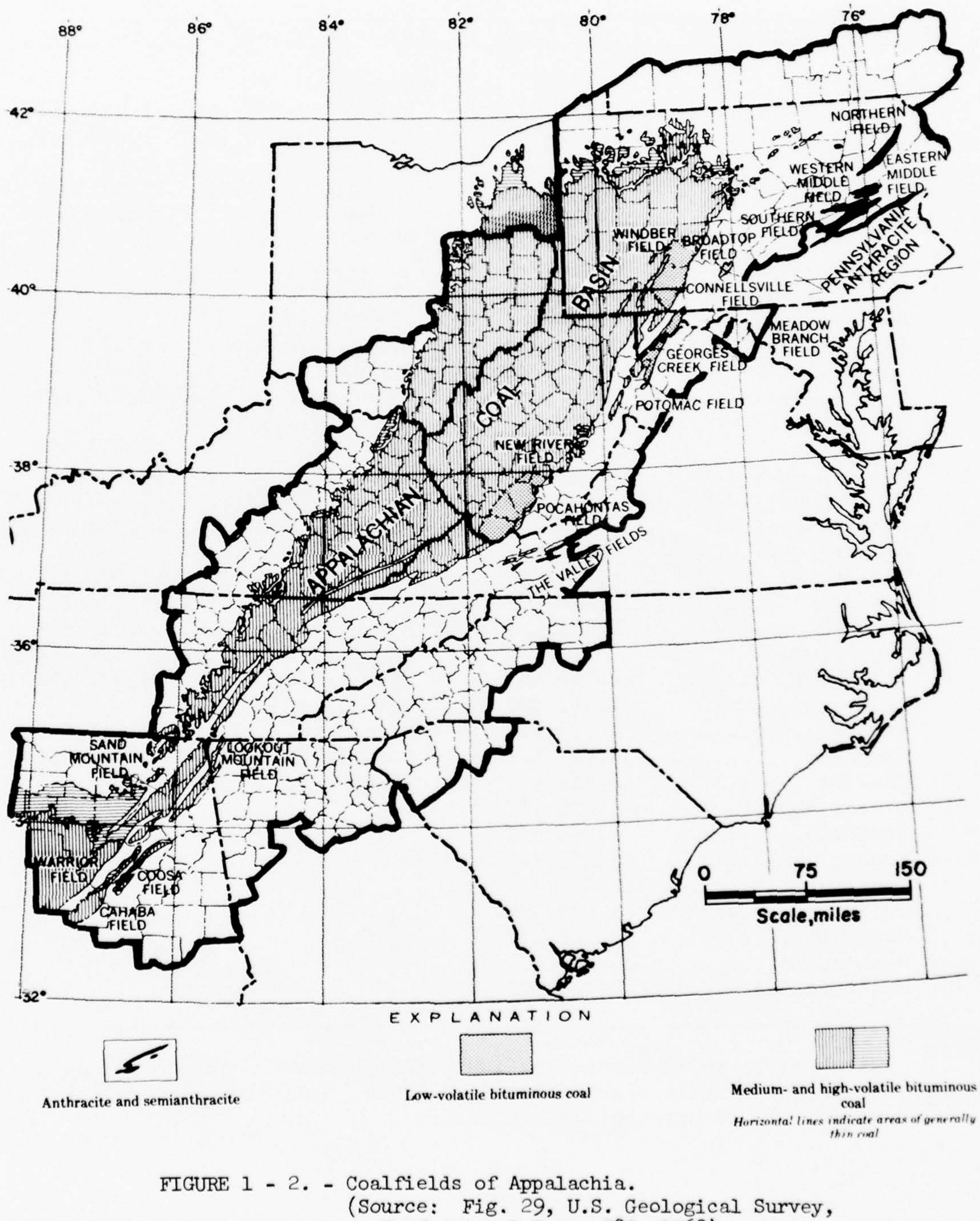

FIGURE 1 - 2. - Coalfields of Appalachia.
(Source: Fig. 29, U.S. Geological Survey, Professional Paper 580, 1968)

TABLE 1 - 2. - Counties in the Appalachian Region producing more than 1 million tons of bituminous coal in 1965[1/]

State and county	Net tons	State and county	Net tons
Alabama		Tennessee	
Jefferson........	7,330,030	Anderson..........	2,032,067
Tuscaloosa.......	1,187,750	Campbell..........	1,075,219
Walker...........	4,305,506	Virginia	
Kentucky		Buchanan..........	15,291,075
Bell.............	2,247,149	Dickenson.........	8,835,044
Clay.............	1,482,991	Russell...........	1,736,472
Floyd............	4,957,516	Wise..............	7,280,428
Harlan...........	5,634,624	West Virginia	
Knott............	2,371,683	Barbour...........	3,366,478
Leslie...........	1,864,239	Boone.............	8,597,183
Letcher..........	5,787,726	Brooke............	1,020,340
Perry............	3,922,686	Fayette...........	6,237,122
Pike.............	15,420,122	Grant.............	W
Ohio		Harrison..........	8,157,561
Belmont..........	7,697,431	Kanawha...........	10,938,272
Coshocton........	2,606,270	Logan.............	16,343,383
Harrison.........	8,585,267	Marion............	14,092,888
Jefferson........	4,970,421	Marshall..........	W
Morgan...........	1,800,314	McDowell..........	17,101,525
Noble............	2,984,783	Mercer............	1,325,271
Tuscarawas.......	2,935,439	Mingo.............	5,639,598
Pennsylvania		Monongalia........	8,977,472
Allegheny........	4,978,693	Nicholas..........	8,031,428
Armstrong........	4,792,801	Ohio..............	W
Butler...........	2,233,947	Preston...........	3,847,195
Cambria..........	8,927,380	Randolph..........	1,027,221
Clarion..........	3,244,423	Wyoming...........	14,098,745
Clearfield.......	7,030,753		
Fayette..........	1,208,613		
Greene...........	12,342,948		
Indiana..........	6,634,754		
Jefferson........	1,839,339		
Somerset.........	3,746,572		
Washington.......	14,239,997		
Westmoreland.....	4,146,522		

W Withheld to avoid disclosing individual company confidential data.
1/ Source - Minerals Yearbook 1965, vol. II, Mineral Fuels, Bureau of Mines, U.S. Department of the Interior.

TABLE 1 - 3. - Number of bituminous coal mines and percentage of production by size of mine for States in the Appalachian Region in 1965 1/

State	500,000 tons and over		200,000 to 500,000 tons		100,000 to 200,000 tons		50,000 to 100,000 tons		10,000 to 50,000 tons		Less than 10,000 tons		Average production per mine tons 2/
	No. of mines	Pct. of output	No. of mines	Pct. of output	No. of mines	Pct. of output	No. of mines	Pct. of output	No. of mines	Pct. of output	No. of mines	Pct. of output	
Alabama.......	8	53.2	8	17.8	13	13.2	10	5.0	51	7.4	116	3.4	71,998
Kentucky 3/....	32	51.2	32	12.0	52	8.5	112	9.1	550	14.1	1,049	5.1	26,840
Maryland......	-	-	1	16.8	1	10.8	2	13.0	22	45.6	43	13.8	17,323
Ohio 4/........	21	57.2	16	12.0	30	10.1	59	10.2	142	8.9	149	1.6	109,950
Pennsylvania..	39	50.3	32	12.8	57	10.0	153	12.7	379	11.8	480	2.4	70,446
Tennessee.....	1	11.0	2	8.3	10	24.2	16	17.5	73	30.1	128	8.9	25,501
Virginia......	8	27.8	13	13.1	11	4.3	51	10.1	521	34.8	667	9.9	26,792
West Virginia.	86	60.3	80	16.6	78	7.5	112	5.5	535	7.9	769	2.2	89,974
Total......	195		184		252		515		2,273		3,401		
Average for Appalachia		52.3		14.1		8.7		8.6		12.7		3.6	55,500

1/ Source - Minerals Yearbook 1965, vol. II, Mineral Fuels, Bureau of Mines, U.S. Department of the Interior.
2/ Production from mines within the Appalachian Region only.
3/ Includes a count of 92 mines in western Kentucky outside the Appalachian Region.
4/ Includes a count of 82 mines outside of the Appalachian Region.

TABLE 1 - 4. - Bituminous coal production statistics for the Appalachian Region, 1965 by State and type of mining[1/]

State[2/]	Underground mining: Number of mines	Underground mining: Share of total production (pct.)	Underground mining: Average value per ton (f.o.b. mines)	Strip mining: Number of mines	Strip mining: Share of total production (pct.)	Strip mining: Average value per ton (f.o.b. mines)	Auger mining: Number of mines	Auger mining: Share of total production (pct.)	Auger mining: Average value per ton (f.o.b. mines)	Total: Number of mines	Total: Average value per ton (f.o.b. mines)
Alabama.........	143	66.9	$8.22	58	32.4	$4.99	5	0.7	$6.67	206	$7.16
Eastern Kentucky	1,548	80.0	4.24	73	9.5	3.13	114	10.5	3.04	1,735	3.78
Maryland........	32	36.0	4.02	35	60.9	3.43	2	3.1	3.00	69	3.63
Ohio............	90	30.5	4.31	195	65.1	3.49	50	4.4	3.17	335	3.71
Pennsylvania....	494	69.3	5.68	581	29.6	3.69	65	1.1	3.69	1,140	5.07
Tennessee.......	180	61.1	3.80	41	35.2	3.20	9	3.7	3.32	230	3.57
Virginia........	1,153	86.2	4.27	56	9.1	2.98	62	4.7	2.90	1,271	4.09
West Virginia...	1,383	89.9	5.00	191	7.0	3.64	86	3.1	3.82	1,660	4.87
Total......	5,023			1,230			393			6,646	
Average for Appalachia		76.3	5.03		19.9	3.62		3.8	3.37		4.68

1/ Source - Minerals Yearbook 1965, vol. II, Mineral Fuels, Bureau of Mines, U.S. Department of the Interior.
2/ Individual State totals include only those counties located in Appalachia with the exception of average value per ton for Kentucky and Ohio which were computed using data from mines both within and outside Appalachia.

TABLE 1 - 5. - Bituminous coal production and value in the Appalachian Region, by Water Subregions, 1961-65

Subregion	1961	1962	1963	1964	1965
Production (thousand short tons)					
B	10,877	11,222	13,435	15,864	17,832
E	12,899	12,865	12,340	14,272	14,559
F	91,385	95,713	103,792	114,130	119,853
G	114,906	122,981	139,292	143,750	150,994
H	12,340	12,977	13,973	13,722	14,449
I	9,061	10,732	10,840	11,554	11,246
J	35,553	35,008	36,024	37,221	39,875
Total	287,021	301,498	329,696	350,513	368,308
Value in thousand 1958 constant dollars					
B	59,769	59,887	68,172	84,947	94,619
E	96,806	103,422	100,661	110,678	115,150
F	475,259	500,595	536,819	595,616	624,667
G	586,409	624,646	710,884	739,878	773,875
H	59,159	61,852	62,570	55,057	62,533
I	42,189	52,847	51,651	53,986	53,691
J	154,027	149,835	156,305	157,485	175,091
Total	1,473,618	1,553,084	1,687,062	1,797,647	1,899,626
Distribution of production (percent)					
B	4	4	4	4	5
E	5	4	4	4	4
F	32	32	32	33	32
G	40	41	42	41	41
H	4	4	4	4	4
I	3	3	3	3	3
J	12	12	11	11	11
Total	100	100	100	100	100
Distribution of value (percent)					
B	4	4	4	5	5
E	7	7	6	6	6
F	32	32	32	33	33
G	40	40	42	41	41
H	4	4	4	3	3
I	3	3	3	3	3
J	10	10	9	9	9
Total	100	100	100	100	100

In 1965, 6,646 mines in the Appalachian Region produced 369 million tons of bituminous coal valued at $1.9 billion 1958 constant dollars ($1.7 billion current dollars) (table 1 - 5). This was the largest tonnage produced in Appalachia since 1957 when output of 372 million tons was recorded.

Water Subregion G led in production with 151 million tons, followed by Subregion F, with 120 million tons; Subregion J, with 39 million tons; and Subregions B, E, H, and I, each with less than 20 million tons. Subregion G contributed 41 percent of the total production and value of Appalachian bituminous coal, and Subregion F had 32 percent of the production, and 33 percent of the value. Subregion J accounted for 11 percent of the total production but only 9 percent of total value.

The bituminous coal produced in Appalachia during 1965 represented 72.0 percent and 74.6 percent, respectively, of the National production and value for bituminous coal and lignite. The Region's share of the National output has remained fairly constant over the past 20 years, varying from 71.2 percent to 75.7 percent of total production.

Major Uses and Economic Importance of the Industry

Separate statistics were not available for the Appalachian Region on the consumption of bituminous coal by consumer class. Bituminous coal production from the Region was about three-fourths of the National total, and tonnages consumed by each industry in Appalachia were proportional, unless otherwise noted. The largest use for bituminous coal in the United States was fuel for power plants. In 1965, 243 million tons of bituminous coal was consumed by electric utilities; of this, about 60 percent, or 146 million tons, was estimated to have been produced in the Appalachian Region. The steel industry used 67 million tons of bituminous coal for coke manufacture, of which over 90 percent was from mines in the Appalachian Region. About 102 million tons of bituminous coal was used by other industrial consumers and about 50 million tons was exported from the Region in 1965. Of all mineral commodities produced in Appalachia, bituminous coal was the largest in tonnage, value, and wages paid.

Between 1961 and 1965, the value of bituminous coal produced in the Appalachian Region increased 29 percent (table 1 - 5). Growth in coal production accounted for most of the rise in the total mineral value in the 5 year period. As a result, the value of bituminous coal increased from 64.8 percent of the total mineral value produced in 1961 to 69.3 percent in 1965. In 1965, the wages of the men working at the mines were estimated at $629 million. Demand for mining equipment and supplies manufactured within the Region has been a secondary contribution of the coal industry to the economy of the area.

Although bituminous coal was the major resource of the Appalachian Region and the leading source of mining employment and mineral wealth, it has been considered by many to be responsible for most of the economic ills of Appalachia. Critics point to the substantial unemployment in the coal mining areas due to technologic changes and improvements and to the damage to land, water, and scenery arising from strip mining and acid mine drainage, which are directly identifiable with the coal industry. Employment in the coal industry in Appalachia dropped from 338,000 men in 1950 to 112,000 men in 1965, which were years of comparable production.

Resource Potential

The Appalachian Bituminous Coal Fields have yielded over 23 billion tons of coal from the earliest record to January 1, 1966. Remaining resources are estimated to be 313.2 billion tons of which roughly half is considered a recoverable resource. The magnitude of this resource can be best appreciated by the realization that this represents 425 years of production at the 1965 rate (276 years at the 1980 projected rate of production).

Although the reserves of bituminous coal in Appalachia are very large, they represent only 10 percent of the total coal resources of the United States in terms of tonnage. However, on a Btu basis the percentage is much larger because the large tonnage of lower rank coals in the Rocky Mountain and northern Great Plains regions has a lower heat content than the bituminous coal in Appalachia.

Coalbeds of Appalachia occur in rocks of Permo-Pennsylvanian and Pennsylvanian age. The beds are of varied thickness and extent and occur at irregular stratigraphic intervals throughout the sequence of sedimentary rocks. In Alabama, 43 coalbeds have been named and described, of which 38 are thick enough locally to be mined economically. In Kentucky, 190 coalbed names have been used, but different names have been applied locally to the same bed or beds, so that the actual number of beds is much smaller. About 33 beds are believed to be thick and continuous over considerable areas. In Ohio, 67 coalbeds have been named and described, and 24 of these have been used in the preparation of resource estimates. In Pennsylvania, 36 beds have been named and described, of which 19 have been used in the preparation of resource estimates. In Tennessee, 45 beds have been named and described and 27 have been used in preparation of resource estimates. In Virginia, 60 named beds have been used in the preparation of resource estimates. In West Virginia, 117 beds have been named and described, and 62 are thick enough locally to be mined economically.

Of the many coalbeds found in Appalachia a few are thick and continuous over large areas and a small group of beds has yielded the bulk of past production. Among these in the northern part of Appalachia

are the Pittsburgh, Upper Freeport, and Lower Kittanning beds. In the southern part, the more extensively mined beds are the Fire Clay and Upper Elkhorn No. 3 beds in Kentucky, the Pocahontas beds in Virginia and adjacent parts of West Virginia, the Sewanee bed in Tennessee, the Pratt bed and beds in the Mary Lee coal zone in Alabama. Considering that the Pittsburgh bed alone has yielded an estimated 35 percent of the cumulative past production of the Region and 21 percent of the cumulative past production of the United States, it is likely that the other beds collectively have yielded about 65 percent of the cumulative past production of the Region and about 50 percent of the cumulative past production of the United States.

The distribution of coal reserves by State plus other salient data on the coal resources of Appalachia are given in table 1 - 6. As noted in column 7 of this table, West Virginia has the largest estimated reserve followed in order by Pennsylvania, eastern Kentucky, and Ohio.

Problems and Outlook

The mining and supplying of acceptable quality coal for powerplant, metallurgical or other use imposes a variety of problems. Increased mine mechanization has produced greater quantities of finer sized materials and associated impurities which require intensive preparation and blending of coals. The quantity of fine-sized coal that presently cannot be economically recovered from preparation plant refuse and effluents will increase with the expansion of production and will require more effective means of disposal to satisfy air and stream pollution regulations. Competition from other fuels requires continuously advancing technology to reduce costs of production, preparation, and transportation; provide increased efficiencies and greater convenience in the use of coal; and to dispose or make use of its waste-products.

The newest threat to coal's largest market is the use of nuclear energy for generating electric power. By 1980, nuclear plants could account for 17 percent of the generating capacity if construction proceeds at the present rate of announced expansion. To counteract this trend, the coal industry has introduced cost reducing innovations such as pipeline transmission, unit-train transportation concepts, and mine-mouth electric power generation plants. There has also been some pressure to introduce legislation that would remove the subsidy on nuclear power and restrict imports of residual oil used in powerplants.

In recent years, increased awareness of social and health problems has inspired legislation that would add to the problems of mining and use of coal. Land reclamation and water pollution regulations designed to minimize damages from future mineral exploration and mining would require modification of mining practices to adhere to environmental standards. Air quality control would require the elimination of or a sharp reduction in the quantity of sulfur dioxide released to the

TABLE 1 - 6. - Bituminous coal resources of Appalachia, January 1, 1965, by States[1/]
(in millions of short tons)

State	Resources determined by mapping and exploration					Estimated additional resource in unmapped and unexplored areas	Estimated total remaining resources in the ground	Estimated recoverable resources assuming 50 percent recoverability in mining
	Original or remaining resources in the ground		Resources depleted to January 1, 1965		Remaining resources January 1, 1965			
	Date of estimate	Tons (millions)	Production	Production plus loss in mining[2/]				
	Column 1	Column 2	Column 3	Column 4	Column 5 (column 2 less column 4)	Column 6	Column 7 (column 5 plus column 6)	Column 8 (half of column 7)
Alabama.......	1958	3/13,774	89	178	13,596	20,000	33,596	16,798
Georgia.......	1953	4/100	12	24	76	30	106	53
Eastern Kentucky....	1956	4/32,271	355	710	31,561	24,000	55,561	27,780
Maryland......	1950	4/1,200	11	22	1,178	400	1,578	789
Ohio..........	1960	3/46,488	2,230	4,460	42,028	2,000	44,028	22,014
Pennsylvania..	1928	75,093	8,619	17,238	57,855	0	57,855	28,927
Tennessee.....	1959	4/2,748	36	72	2,676	2,000	4,676	2,338
Virginia......	1952	3/12,051	933	1,866	10,185	3,000	13,185	6,592
West Virginia.	1940	3/116,618	6,993	13,986	102,632	0	102,632	51,316
Total....		300,343	5/19,278	38,556	261,787	51,430	313,217	156,607

Source - Table 36, U.S. Geological Survey, Professional Paper 580, 1968.
1/ Includes beds 14 inches or more thick to a maximum depth of 3,000 feet.
2/ Assuming past losses equal past production.
3/ Remaining resources as of January 1 of year noted.
4/ Estimated original resources. Year noted is date of publication of estimate.
5/ Cumulative production from earliest record to January 1, 1966, is about 23 billion tons. Column 3 shows production since date of estimate.

atmosphere during the combustion of coal. The development of acceptable standards for land use and air pollution control based on present knowledge and technology is being pursued by business interests and government agencies.

The outlook for coal production from the Appalachian Region is for a continual increase at an annual rate of 3.5 percent to 1980. In that year, production of about 570 million tons is expected. The continual rise in production is based, principally, on a dynamic electric utilities market that has increased its share of U.S. coal consumption from less than 20 to over 50 percent in the past 15 years. During this period, consumption of coal for generation of electricity has increased 176 percent. In addition, the requirements of industry in an economy that is expanding at about 4 percent per year, the rise in population, and the increasing per capita use of electricity are expected to add nominal increments to the demand for coal.

New large-scale uses for coal may develop from private and government-financed research and add to the projected production for 1980. Some research activities directed toward increasing consumption of coal are in hydrogenation, gasification, gas synthesis, and carbonization. Lately, considerable interest has been shown in coal-to-gasoline conversion processes.

Anthracite

Geographic Distribution and Structure of the Industry

The anthracite fields cover an area of 484 square miles in eastern Pennsylvania, mainly inside the Appalachian Region. The anthracite-producing area in Appalachia (fig. 1 - 3) is separated by coal-trade usage into three regions: the Wyoming, synonymous with the Northern field; the Lehigh, composed of the Eastern Middle field and that portion of the Southern field east of Tamaqua; and the Schuylkill, which includes all the Western Middle field and that portion of the Southern field west of Tamaqua. The coalfields are spread over an area of about 3,300 square miles in eight Appalachian and two adjacent counties: Carbon, Columbia, Lackawanna, Luzerne, Northumberland, Schuylkill, Susquehanna, and Wayne, and neighboring Dauphin and Lebanon. Anthracite is also recovered in Berks, Lancaster, and Snyder Counties by dredging. A small quantity of semianthracite produced in Sullivan County is included in annual anthracite production statistics. However, 95 percent of the anthracite production from Pennsylvania comes from the Appalachian Region with only Berks, Dauphin, Lancaster, and Lebanon Counties lying just outside the eastern boundary of the Region. Almost three-fourths of the 1965 anthracite production was mined in Luzerne and Schuylkill Counties, which contain about 60 percent of the area of the anthracite field.

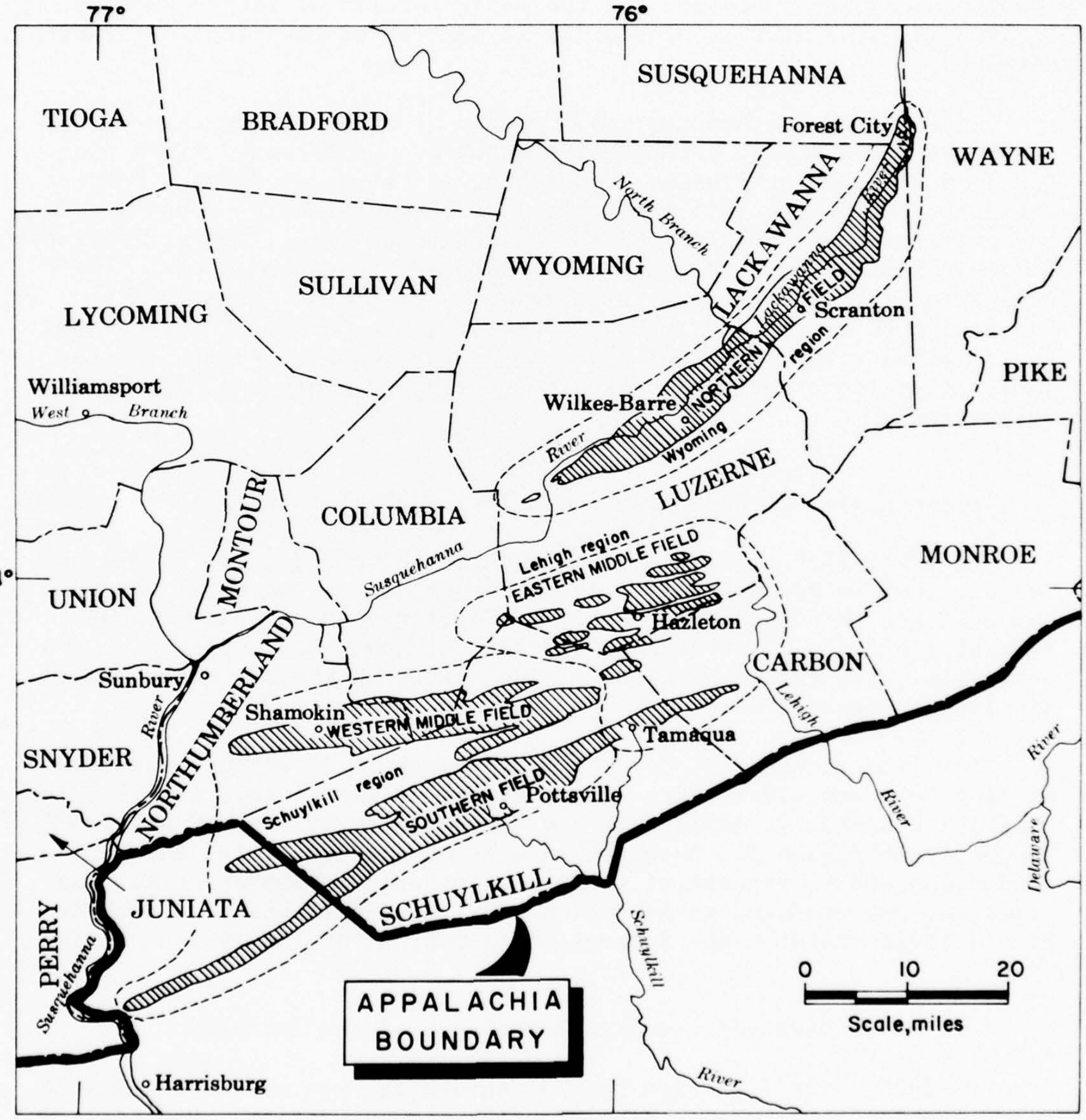

FIGURE 1 - 3. - Anthracite Fields of Pennsylvania.
(Source: Fig. 43, U.S. Geological Survey, Professional Paper 580, 1968)

The structure of the anthracite industry ranges from small two-man independent operations to large integrated companies that operate a number of mines, preparation plants, and other facilities employing a thousand or more people. There are many small underground mines or strip mines producing run-of-mine coal for sale to preparation plants. More than 400 small underground mines employing five men or fewer were operated in 1965. However, similar to the bituminous coal industry, a few large companies account for the major portion of the production. In 1965, 31 companies accounted for 71 percent of the total anthracite output.

In 1965 more anthracite was produced by strip mining than by any other method, about 40 percent of the total. Underground mines produced 35 percent, culm banks 20 percent, and river dredging 5 percent. The distribution for 1965 was typical of the anthracite production for the previous 5 years. In 1963, 834 underground mines, 200 strip mines, 112 culm banks, and 15 dredges were operated. Based on data in the 1965 annual report of the Anthracite Division of the Pennsylvania Department of Mines and Mineral Industries, the number of strip mines has remained fairly constant over the past 2 years; however, for the same period there was a decrease in underground mines and culm bank operations.

Current Regional Production and Relationship to National Production

In 1965, 14.9 million tons of anthracite valued at $122 million was produced in Pennsylvania. About 95 percent of the total was produced within the Appalachian Region. There was some production of semianthracite coals in Arkansas, Colorado, New Mexico, Virginia, and Washington, but this production is included with the bituminous coal and lignite statistics.

The 1965 anthracite production and value in Appalachia was 14.0 million tons and 130 million 1958 constant dollars (table 1 - 7). The anthracite fields in Appalachia are divided between Water Subregion A and Water Subregion B. About 84 percent of the 1965 total anthracite production and 85 percent of value was produced in Subregion A. The remainder was produced in Subregion B. This distribution of anthracite activity between the Subregions is typical of the 1961-65 period.

Major Uses and Economic Importance of the Industry

In 1965, over 6 million tons of anthracite was used for domestic space heating, the largest single outlet for anthracite. Public utilities consumed 2,158,000 tons; the iron and steel industry consumed about 2 million tons; and 851,000 tons was exported. In addition, 1.1 million tons was exported for use by the U.S. Armed Forces in Germany. The remainder was used by the cement industry,

TABLE 1 - 7. - Anthracite production and value in the Appalachian Region, by Water Subregions, 1961-65

Subregion	1961	1962	1963	1964	1965
Production (thousand short tons)					
A	14,219	14,042	14,897	13,261	11,783
B	2,438	2,052	2,458	3,004	2,226
Total	16,657	16,094	17,355	16,265	14,009
Value in thousand 1958 constant dollars					
A	129,108	126,507	144,717	131,941	111,241
B	17,724	16,347	20,975	26,445	18,874
Total	146,832	142,854	165,692	158,386	130,115
Distribution of production (percent)					
A	85	87	86	82	84
B	15	13	14	18	16
Total	100	100	100	100	100
Distribution of value (percent)					
A	88	89	87	83	85
B	12	11	13	17	15
Total	100	100	100	100	100

briquetting plants, as colliery fuel, and for a variety of other purposes for which quantitative consumption data are not available.

In 1965 the anthracite industry employed 10,130 men, who worked an average of 204 days. Estimating an average wage of $26 per day, the industry paid approximately $59 million in wages in 1965.

The industry has not been able to meet the competitive challenge of petroleum and natural gas. As recently as 1950, anthracite accounted for 34 percent of the total fuels consumed (calculated on Btu content) in major anthracite sales areas. By 1964, anthracite's share had dwindled to 8 percent while fuel oil and natural gas rose to 64 and 28 percent, respectively. This switch to the "convenience" fuels has had a vital impact on the industry. During the past 20 years, annual production of anthracite has decreased from 60.5 million to 14.9 million tons.

Employment in the anthracite industry declined from 78,145 to 10,130 men in the same period. The impact upon the local economy can be gauged from the comparative employment data for Subregion A where in 1950 and 1960 more than 80 percent of the Nation's anthracite was produced. In 1950 the anthracite industry employed 67,000 men, 19 percent of the total 352,000 employed in the Subregion. By 1960 the anthracite industry employed 16,000 men, only 5 percent of the 313,000 employed. In the decade, anthracite employment decreased by 51,000 and total employment by 39,000. In 1965 anthracite employment in Subregion A was 9,011, about 3 percent of total employment in the Subregion. Anthracite employment is important locally even though the number employed decreased 88 percent in 20 years.

Resource Potential

The anthracite-bearing rocks of eastern Pennsylvania are of Pennsylvanian age. Their original thickness is unknown because the upper part of the sequence has been eroded. Some of the coalbeds, particularly in the upper sections, are of only local importance. The more important coalbeds are the Lykens Valley, Buck Mountain, Sevenfoot, Skidmore, Mammoth, Holmes, Primrose, and Orchard of the Southern and both Middle fields; and the Red Ash (or Dunmore), Ross, Skidmore (or March), Pittston (or Baltimore), Lance (or Checker), Diamond, and Hillman coalbeds of the Northern field. The 15 coalbeds are the source of more than 90 percent of the coal mined in the Anthracite Region.

Anthracite resources as of January 1, 1965, in the Pennsylvania Anthracite Region are estimated to be 22.6 billion tons (table 1 - 8). Of this, about 14.2 billion tons is in the Southern field, about 4.9 billion tons is in the Western Middle field, and about 3.5 billion

TABLE 1 - 8. - Pennsylvania anthracite resources, January 1, 1965
(in billions of short tons)

Estimated original resources (includes coal 14 inches or more in thickness)	31.3
Total production to 1965	5.3
Estimated losses incurred in underground mining (estimated at 61 percent rate of recovery)	3.4
Remaining resources as of January 1, 1965	22.6
Remaining resources less than 3,000 feet below surface	19.0
Probable recoverable resources, January 1, 1965 (61 percent recovery of coal less than 3,000 feet below surface)	11.6

Source: Table 41, U.S. Geological Survey, Professional Paper 580, 1967.

tons is in the Eastern Middle and Northern fields. This resource is less than 3,000 feet below the surface with the exception of about one-fourth the reserve of the Southern field. Assuming an average recovery of 61 percent that is possible with existing mining technology, it would be possible to recover 11.6 billion tons of the estimated 19.0 billion tons that lie less than 3,000 feet below the surface. Reserves economically recoverable are very much smaller. Much of the resource lies below the water table, thus would require large-scale pumping and water treatment before mining would become possible.

Problems and Outlook

The main use for anthracite has been as domestic fuel. From the early 1800's, the use for anthracite grew rapidly as transportation systems were developed, reaching a peak of 100 million tons in 1917. Production since 1917 has decreased steadily to 14.9 million tons in 1965. Petroleum and natural gas began to make serious inroads into anthracite's markets in the 1930's; anthracite production decreased as the use of petroleum and natural gas increased for space heating in the anthracite sales area.

The anthracite industry, unlike the bituminous coal industry, was not successful in keeping costs low or in retaining and expanding major new markets for its product when its primary markets declined. The costs of mining steeply pitching beds of anthracite were difficult to reduce. The industry opened more strip mines in an effort to increase productivity and to lower mining costs. In 1946, 21 percent of anthracite production was strip mined, compared with more than 40 percent in 1965. Productivity during the 1946-65 period increased from 2.84 to 6.55 tons per man-day. Most of the increased productivity was attributable to the increased proportion of output from strip mines. Strip mine sites with shallow overburden are virtually exhausted, and stripping now follows the coalbed to deeper pits; thus mining costs are increasing.

If the anthracite industry is to survive, it must do more than maintain its present markets; new ones must be created. The industry faces major problems and the outlook is not promising. The space heating market has been largely lost to heating oils and natural gas. The public utility market has been declining. This market has been supplied primarily with river and culm bank coal; it may cease to exist when these sources become exhausted. The only relatively stable market for anthracite has been the steel and cement industries. Some increase in demand is anticipated for sintering and pelletizing iron ore, for industrial carbon, and for metallurgical uses.

Exports of anthracite have declined over the past 20 years from a high of 8.5 million tons in 1947 to a low of 851,000 tons in 1965. The Canadian market has declined from about 4.5 million tons in 1946 to

643,000 tons in 1965. The European market has fluctuated from several hundred thousand tons to several million tons. As recently as 1963 the European market accounted for 2.5 million tons of anthracite; in 1965 exports were only 134,000 tons. The long term outlook for anthracite exports is that of a continuing general decline. The U.S. Armed Forces in Germany may continue to use about 1 million tons per year.

The growth rate for anthracite to 1980 is expected to be negative. The current 1967 production was about 12 million tons. If present trends continue, by the year 2000 anthracite production will have dwindled to 4 million tons annually, and will have become a relatively minor industry serving only small markets. No large anthracite markets have been developed in recent years and there is little prospect for such development. Research has been performed on the manufacture of high-Btu gas from anthracite, the substitution of calcined anthracite briquets for metallurgical coke, its use as low-ash coal for nonfuel purposes, and its use in the production of anthracite coal chemicals. However, no promising results have been forthcoming. The conclusion on analyzing all the major markets for anthracite is that production will continue to decline. Operators having high mining costs will be forced to close their mines. Strip mining may become even more important in the anthracite industry.

Petroleum and Natural Gas

Geographic Distribution and Structure of the Industry

Petroleum and natural gas occur widely in the Appalachian Region. As shown in figures 1 - 4 and 1 - 5, oil and gas fields are found in all States of Appalachia, except in the Carolinas and Georgia. However, the most extensive fields are in, and the greatest production has come from, Pennsylvania, Ohio, Kentucky, and West Virginia, in that order.

Much of the oil and natural gas in Appalachia is produced by small independent companies using outmoded equipment. Wells are relatively shallow and generally have low productive capacities. Secondary recovery accounts for much of the oil production. In 1965, 67 percent of Pennsylvania's production resulted from waterflooding. Natural gas production has remained at a relatively even level for many years, but in 1965 the discovery of five new gas pools in Pennsylvania resulted in an increase in production. Some of the companies producing natural gas recover and sell natural gas liquids (LP gases and natural gasoline). Production in 1965, from Kentucky, Ohio, Pennsylvania, and West Virginia, totaled almost 12 million barrels.

Natural gas is stored in depleted gas reservoirs to enable utility companies to more efficiently supply peak demand during periods of cold weather. Storage capacity in the Appalachian Region includes almost

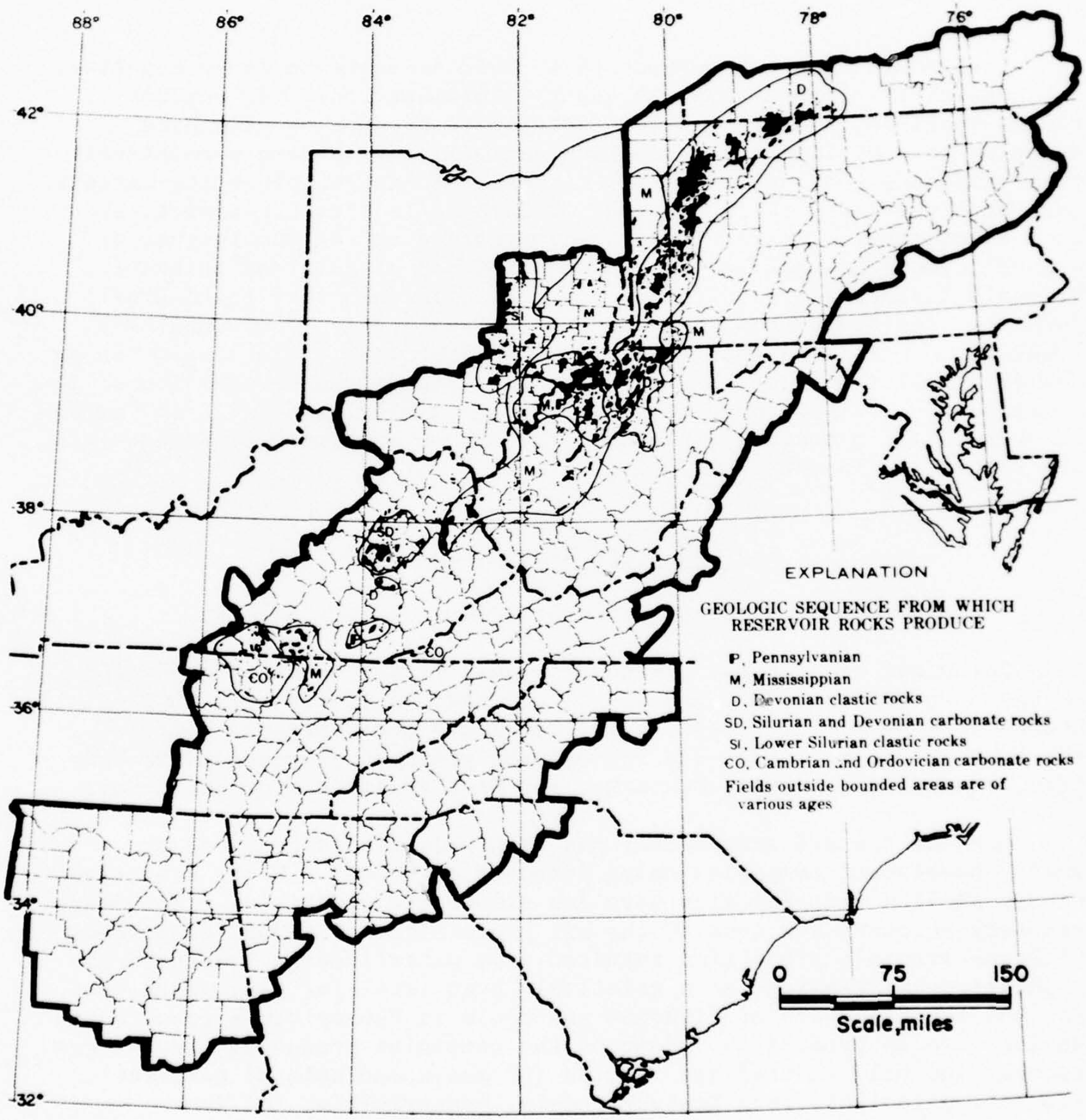

FIGURE 1 - 4. - Oilfields in the Appalachian Region.
(Source: Fig. 42, U.S. Geological Survey, Professional Paper 580, 1968)

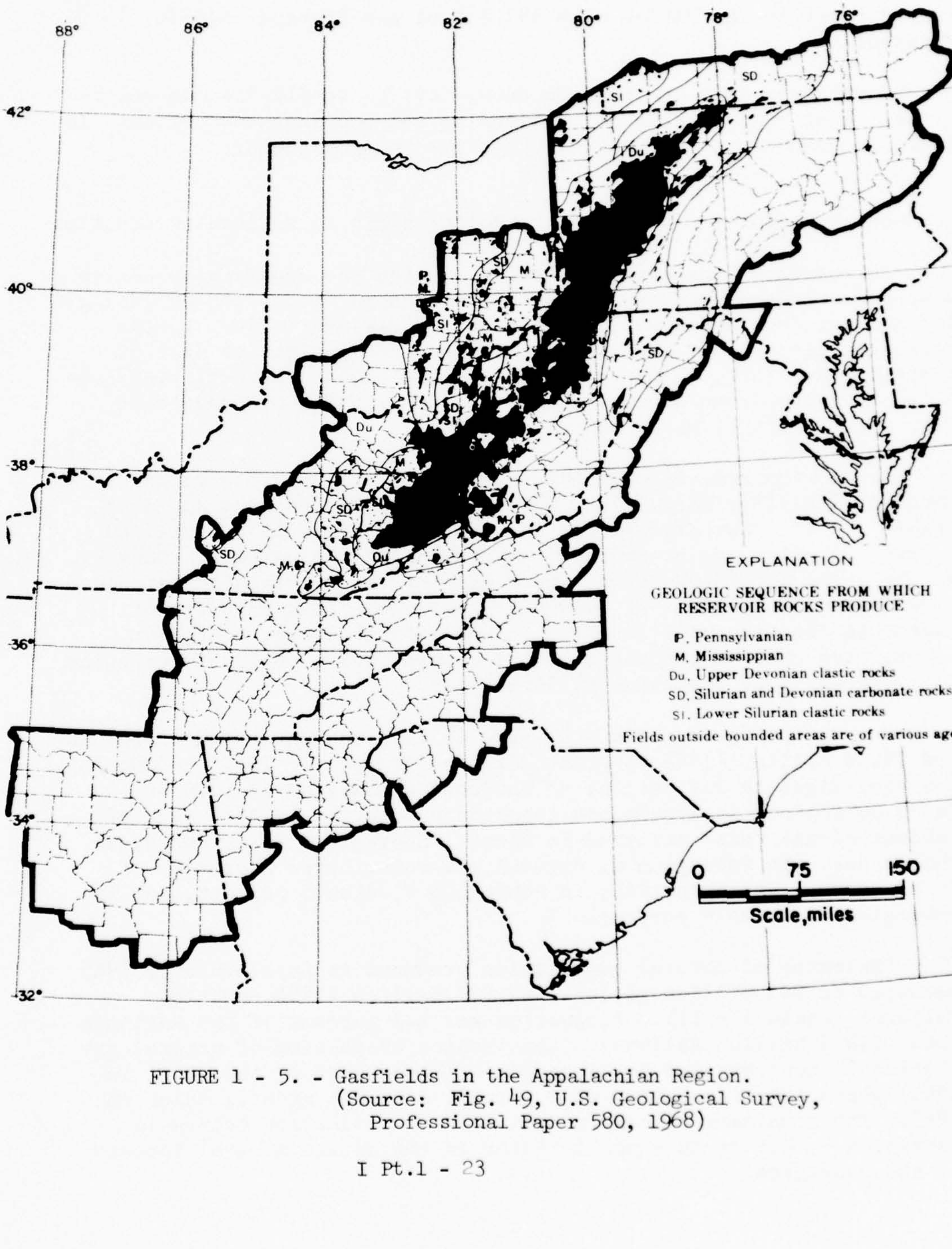

FIGURE 1 - 5. - Gasfields in the Appalachian Region. (Source: Fig. 49, U.S. Geological Survey, Professional Paper 580, 1968)

all of the storage reservoirs in Kentucky, New York, Ohio, Pennsylvania, and West Virginia. Total capacity in these five States at the end of 1965 was 1,789 Bcf or 44 percent of the United States total. Pennsylvania ranked first in the Nation with 697 Bcf of gas storage capacity in 67 reservoirs.

Appalachia does not produce enough oil to supply its own refineries. Most of the crude oil refined is shipped into the Region. In 1965, 13 companies operated 16 refineries in Appalachia.

Current Regional Production and Relationship to National Production

Petroleum and natural gas statistics for the Appalachian Region must be estimated because little information on production by geologic horizon, or from areas smaller than States, is available. In the following discussion, production data for the Appalachian part of Kentucky, New York, Ohio, and Tennessee are based upon estimates supplied by State agencies concerning the distribution of production within the State by water subregions.

Production and value of crude petroleum in 1965 totaled an estimated 17.8 million barrels and $64 million (1958 constant dollars) (table 1 - 9). Compared to the National production of 2.8 billion barrels, Appalachian production was minuscule, 0.6 percent. However, in the three water subregions where most of the Appalachian petroleum is produced (Subregions F, G, and H), petroleum is a significant factor in the mineral industry. In Water Subregion F, petroleum constituted about 5 percent of total mineral value in 1965; Subregion G, 2 percent, and Subregion H, 10 percent.

Natural gas production and value in 1965 was estimated at 381 Bcf and $92.4 million (1958 constant dollars) (table 1 - 10). Production was equivalent to 2.4 percent of National production (16,000 Bcf). Seven Subregions in Appalachia reported production in 1965, but 97 percent of the total occurred in three: Subregions G, F, and H, in that order. In Subregion G, natural gas contributed 5 percent of total mineral value in 1965; in Subregion F, also 5 percent, and in Subregion H, about 8 percent.

Estimates of natural gas liquids produced in Appalachia in 1965 amounted to 595 million gallons and $28 million (1958 constant dollars) (table 1 - 11). Production was 3.2 percent of the National total (18.5 billion gallons). Appalachian production of natural gas liquids is concentrated in Subregion G (82 percent of the total in 1965) where they accounted for 3 percent of total mineral value in 1965. The remainder of natural gas liquids production occurs in Subregion F, but it is a small factor in the entire mineral industry of the Subregion.

TABLE 1 - 9. - Estimated petroleum (crude) production and value in the Appalachian Region, 1961-65

Subregion	1961	1962	1963	1964	1965
Production (thousand 42-gallon barrels)					
B	1	1	(1/)	(1/)	(1/)
F	8,655	9,263	9,227	8,309	8,505
G	5,456	5,191	5,177	6,812	5,874
H	2,155	2,337	2,426	2,981	3,050
I	1,322	759	514	353	351
J	-	-	3	6	4
Total	17,589	17,551	17,347	18,461	17,784
Value in thousand 1958 constant dollars					
B	$4	$4	$2	$2	$1
F	39,878	40,394	40,218	35,401	35,538
G	18,201	16,706	16,555	21,968	18,684
H	6,386	6,803	7,013	8,713	8,727
I	3,917	2,208	1,482	1,030	1,003
J	-	-	7	13	8
Total	68,386	66,115	65,277	67,127	63,961
Distribution of production (percent)					
B	(2/)	(2/)	(2/)	(2/)	(2/)
F	49	53	53	45	48
G	31	30	30	37	33
H	12	13	14	16	17
I	8	4	3	2	2
J	-	-	(2/)	(2/)	(2/)
Total	100	100	100	100	100
Distribution of value (percent)					
B	(2/)	(2/)	(2/)	(2/)	(2/)
F	58	61	62	53	56
G	27	25	25	33	29
H	9	10	11	13	14
I	6	4	2	1	1
J	-	-	(2/)	(2/)	(2/)
Total	100	100	100	100	100

1/ Less than 500 barrels.
2/ Less than 0.5 percent.

TABLE 1 - 10. - Estimated natural gas production and value in the Appalachian Region, 1961-65

Subregion	1961	1962	1963	1964	1965
		Production (million cubic feet)			
B	3,578	2,472	1,633	1,373	408
E	56	128	177	166	203
F	173,405	164,524	162,631	144,877	144,932
G	193,224	190,616	192,687	191,283	198,465
H	27,880	27,280	27,480	27,000	27,400
I	6,970	6,820	6,870	6,750	6,850
J	-	-	2,085	1,609	3,152
Total	405,113	391,840	393,563	373,058	381,410
		Value in thousand 1958 constant dollars			
B	$971	$658	$435	$366	$103
E	4	13	21	18	26
F	49,454	44,391	42,311	38,332	36,763
G	51,502	50,510	49,414	47,432	46,551
H	6,900	6,679	6,503	6,405	6,447
I	1,733	1,674	1,626	1,602	1,612
J	-	-	483	479	939
Total	110,564	103,925	100,793	94,634	92,441
		Distribution of production (percent)			
B	1	1	(1/)	(1/)	(1/)
E	(1/)	(1/)	(1/)	(1/)	(1/)
F	43	42	41	39	38
G	47	48	49	51	52
H	7	7	7	7	7
I	2	2	2	2	2
J	-	-	1	1	1
Total	100	100	100	100	100
		Distribution of value (percent)			
B	1	1	(1/)	(1/)	(1/)
E	(1/)	(1/)	(1/)	(1/)	(1/)
F	45	43	42	40	40
G	46	48	49	50	50
H	6	6	6	7	7
I	2	2	2	2	2
J	-	-	1	1	1
Total	100	100	100	100	100

1/ Less than 0.5 percent.

TABLE 1 - 11. - Estimated natural gas liquids production and value in the Appalachian Region, 1961-65 1/

Subregion	1961	1962	1963	1964	1965
			Production (thousand gallons)		
F	127,030	131,459	122,744	110,896	104,861
G	517,412	486,878	472,254	475,669	490,044
Total	644,442	618,337	594,998	586,565	594,905
			Value in thousand 1958 constant dollars		
F	$6,979	$6,793	$6,370	$5,499	$4,907
G	26,874	23,282	23,032	22,662	23,089
Total	33,853	30,075	29,402	28,161	27,996
			Distribution of production (percent)		
F	20	21	21	19	18
G	80	79	79	81	82
Total	100	100	100	100	100
			Distribution of value (percent)		
F	21	23	22	20	18
G	79	77	78	80	82
Total	100	100	100	100	100

1/ Includes LP gases and natural gasoline and cycle products.

Total value of petroleum, natural gas, and natural gas liquids produced in Appalachia during 1965 was $184 million (1958 constant dollars), equivalent to 6.7 percent of the total mineral value reported in the Appalachian Region.

Major Uses and Economic Importance of the Industry

The petroleum and natural gas industries in Appalachia provide a source of energy for the Region, but Appalachia is far from self-sufficient in supplies of these fuels. Large quantities of natural gas are shipped into the area for direct consumption while additional quantities are stored in underground storage to meet peak demands during periods of cold weather. In addition, most of the Appalachian crude oil requirement is supplied by sources outside the Region.

The oil fields of the Bradford district of northwestern Pennsylvania and southwestern New York yield exceptionally high quality crude petroleum. This crude oil is especially rich in paraffin-base lubricating oil fractions and merits the highest price in the domestic market. In 1965, the average value for New York crude petroleum was $4.44 per barrel, compared with the National average of $2.86 per barrel. In Pennsylvania, crude petroleum was valued at $4.32 per barrel and in West Virginia $3.85.

During the 5-year period (1961-65), production and value of crude petroleum, natural gas and natural gas liquids averaged about $197 million (1958 constant dollars). Within this period there has been a general overall decline in production and value of these commodities: petroleum by $4.4 million to $64.0 million; natural gas by $18.1 million to $92.4 million; and natural gas liquids by $5.9 million to $28.0 million. In the same 5-year period however, the Nation's output of each increased. Appalachia's participation in domestic production thus declined; its value in 1965 was one-sixth less than in 1961. Even so, in 1965, the fluid hydrocarbons ranked second to coal in value of mineral production in the Appalachian Region.

Resource Potential

Most of the petroleum and natural gas production in Appalachia has come from the shallow fields in the north, which have been extensively drilled and are well defined. The resource potential of the remainder of Appalachia, with the exception of a few local areas, is not great. The greatest potential for discovery of new resources is at greater depth than most of those fields now productive. The Valley and Ridge province, extending 800 miles from central Pennsylvania (where it is 80 miles wide) to Alabama (where it is about 40 miles wide) has had virtually no exploratory drilling. Because of the complex geology of the Valley and Ridge province, and because of the probability that deep drilling would be required, the area is not regarded as having

much potential for the discovery of extensive petroleum or natural gas fields. However, a single significant discovery could stimulate a widespread program of exploration and development.

Approximations of proved petroleum and natural gas reserves of Appalachia are given in table 1 - 12. Petroleum reserve estimates exclude Tennessee and Virginia because statistics for these States are not published separately. The petroleum reserves for Kentucky and Ohio are for the entire States. Estimates of natural gas reserves for Alabama, Maryland, and Tennessee are not published separately and are excluded from the table. Gas reserve estimates for Kentucky, New York, and Ohio include areas outside as well as within Appalachia and consequently do not reflect the true reserve picture of the portion of those States within Appalachia.

Problems and Outlook

The modern petroleum industry began in Appalachia in 1859. Production in Appalachia probably reached its peak in the 1890's, declining generally thereafter except for occasional increases resulting from the discovery of new fields or the introduction of technologically advanced production methods. Much of Appalachia's petroleum is now produced by secondary recovery methods (mostly waterflooding) from oilfields that have reached the stage where natural productivity is significantly low. Low productivity per well is typical. The crude oil industry is characterized by a large number of small independent producing companies using outmoded equipment. New shallow gas pools are discovered periodically, but most are small. No significant increase in reserves is anticipated.

It is likely that future production from the shallow fields in Appalachia will continue to decline slowly unless new petroleum and natural gas reserves are found to replace those presently being exhausted. The greatest opportunity for the discovery of important new oil and gas resources is at depths greater than those now productive. Deeper drilling in areas where shallow fields are currently producing, and in areas where little or no petroleum or natural gas have yet been discovered, might lead to the discovery of new resources which could contribute to increased production from the Region.

TABLE 1 - 12. - Estimated proved reserves of crude oil and natural gas in known fields

State	Crude oil,1/ thousand barrels		Natural gas,2/ million cubic feet	
	Proved reserves Dec. 31, 1966	Change in 1966	Proved recoverable reserves, Dec. 31, 1966	Stored underground at end of 1966
Kentucky.............	101,235	-6,376	1,017,007	55,458
New York.............	10,182	-1,749	120,871	93,419
Ohio.................	101,162	238	755,215	421,570
Pennsylvania.........	72,429	-4,337	1,350,576	501,024
Virginia.............	-	-	37,586	0
West Virginia........	56,573	1,390	2,622,237	334,909
Total Appalachia....	341,581	-10,834	5,903,492	1,406,380
Total U.S...........	31,452,127	99,736	289,332,805	3,224,769

1/ Source: Committee on Reserves and Productive Capacity, American Petroleum Institute, April 3, 1967.

2/ Source: Committee on Natural Gas Reserves, American Gas Association, April 3, 1967.

NONMETALS

Stone

Geographic Distribution and Structure of the Industry

Stone is produced in the Appalachian sections of all States included in the Region and thus in all of the 10 water subregions. Table 1 - 13 shows the number of mines or quarries active in 1965 by State segments and water subregions of Appalachia. The varieties of stone mined or quarried over the last two decades included basalt (traprock), calcareous marl, granite, limestones (high-calcium and dolomitic), marble, sandstone (including quartz and quartzite), and miscellaneous varieties, including slate. Stone is marketed either as broken, crushed, or ground material in selected size ranges, or as the dimensioned product. Crushed stone, however, accounts for the bulk of the total Appalachian stone output and value.

Over the last two decades production of dimension stone in Appalachia accounted for 14 percent and 22 percent of the National output and value, respectively. It was produced in the Appalachian parts of all of the States except Virginia, whose production was outside the Appalachian area, and Mississippi. The States leading in Appalachian production were Georgia, Ohio, and Tennessee; these States accounted for almost two-thirds of the output. In decreasing order of value, the stone varieties produced as the dimension product included marble, sandstone, granite, limestone, and miscellaneous varieties, including slate.

The principal producing areas in Appalachia for marble were in Georgia and Tennessee; for sandstone, in New York, Ohio, Pennsylvania, and Tennessee; for granite, in Georgia and North Carolina; for limestone, in Alabama, Georgia, and Pennsylvania; and for miscellaneous varieties, in Pennsylvania. Dimension stone is worked in operations ranging from small plants with several employees to large installations with complex shaping, sawing, and polishing equipment requiring many workers.

Crushed stone is the term applied to rock broken or crushed to definite size classifications after mining or quarrying. Over the last two decades, crushed stone accounted for over 99 percent and 86 percent respectively, of the total stone output and value in Appalachia. The principal stone varieties mined or quarried in order of output included limestone (and dolomite), granite, sandstone, marble, and miscellaneous types, including slate. In order of production value they were limestone, sandstone, marble, granite, and miscellaneous stone.

Crushed stone was produced in all of the 10 subregions in Appalachia and in all of the Appalachian States except Mississippi.

TABLE 1 - 13. - Stone operations in Appalachia, 1965, classified by State and Water Subregion

State	Water Subregion										State total
	A	B	C	D	E	F	G	H	I	J	
Alabama.........	-	-	-	-	35	-	-	-	-	15	50
Georgia.........	-	-	-	2	21	-	-	-	-	4	27
Kentucky........	-	-	-	-	-	-	8	12	12	-	32
Maryland........	-	10	-	-	-	-	-	-	-	-	10
New York........	-	15	-	-	-	-	-	-	-	-	15
North Carolina..	-	-	-	15	-	-	-	-	-	13	28
Ohio............	-	-	-	-	-	3	52	-	-	-	55
Pennsylvania....	13	68	-	-	-	52	-	-	-	-	133
South Carolina..	-	-	-	4	-	-	-	-	-	-	4
Tennessee.......	-	-	-	-	-	-	-	-	28	72	100
Virginia........	-	-	7	-	-	-	13	-	-	18	38
West Virginia...	-	17	-	-	-	13	23	-	-	-	53
Mississippi.....	-	-	-	-	1	-	-	-	-	-	1
Subregion total.	13	110	7	21	57	68	96	12	40	122	546

For the last two decades, Appalachia produced about 13 percent of the National crushed stone output. In 1964, the last year of complete data, slightly more than 50 percent of the total Appalachian output was contributed by the Alabama, Pennsylvania, and Tennessee segments of the Region while the Georgia, Virginia, and West Virginia segments accounted for about 25 percent.

Limestone, by far the most important type of crushed stone in terms of output and value, was produced in all the Appalachian States in 1964. Limestone comprised over three-quarters of the Region's total crushed stone production over the past two decades. About 60 percent of the 75,833,000-ton regional output in 1964 was attributed to three State segments of Appalachia - Alabama (19 percent), Pennsylvania (18 percent), and Tennessee (23 percent). The combined output of the Kentucky, Ohio, Virginia, and West Virginia segments accounted for 33 percent. Granite, the second ranking stone in output, was produced chiefly by the Georgia, North Carolina, and South Carolina segments, listed in order of output. The Appalachian parts of Pennsylvania, West Virginia, and Tennessee, accounted for the bulk of sandstone output; production was also reported from Ohio, Virginia, North Carolina, Alabama, and Georgia, all listed in order of output. Marble production was reported in four of the 12 Appalachian States. These, in order of output, were Georgia, Alabama, North Carolina, and Tennessee. Small quantities of crushed miscellaneous types - basalt, calcareous marl, slate, and other stone varieties were also produced in the Region. Stone resources, especially limestone (fig. 1 - 6) and sandstones (fig. 1 - 7) are ample at present production rates and are adequate for future expected demands.

Operations were both stationary (fixed installations) and portable or semimobile, with the stationary type predominating. Size of operations ranged from plants producing less than 25,000 tons annually to those with outputs exceeding 500,000 tons.

Current Regional Production and Relationship to National Production

The Appalachian proportion of total U. S. stone production has been declining slightly; for example, from 15 percent in the 1945-49 period to 13 percent in the 1961-65 period. However, while regional output and value have not kept pace with National increases, growth within the Region has been substantial. Over the 1945-64 period, production of crushed stone increased almost fourfold while output of dimension stone rose over fivefold. During the same period, regional production of crushed stone accounted for 13 percent and 15 percent, respectively, of National production and value. The regional output of dimension stone accounted for 15 percent and 22 percent, respectively, of the National production and value of this material. Crushed stone comprised 99.5 percent of the output and 85.6 percent of the value of total Appalachian stone production (crushed and dimension) over the 1945-64 period. These proportions nationally were 99.5 percent and 89.4 percent,

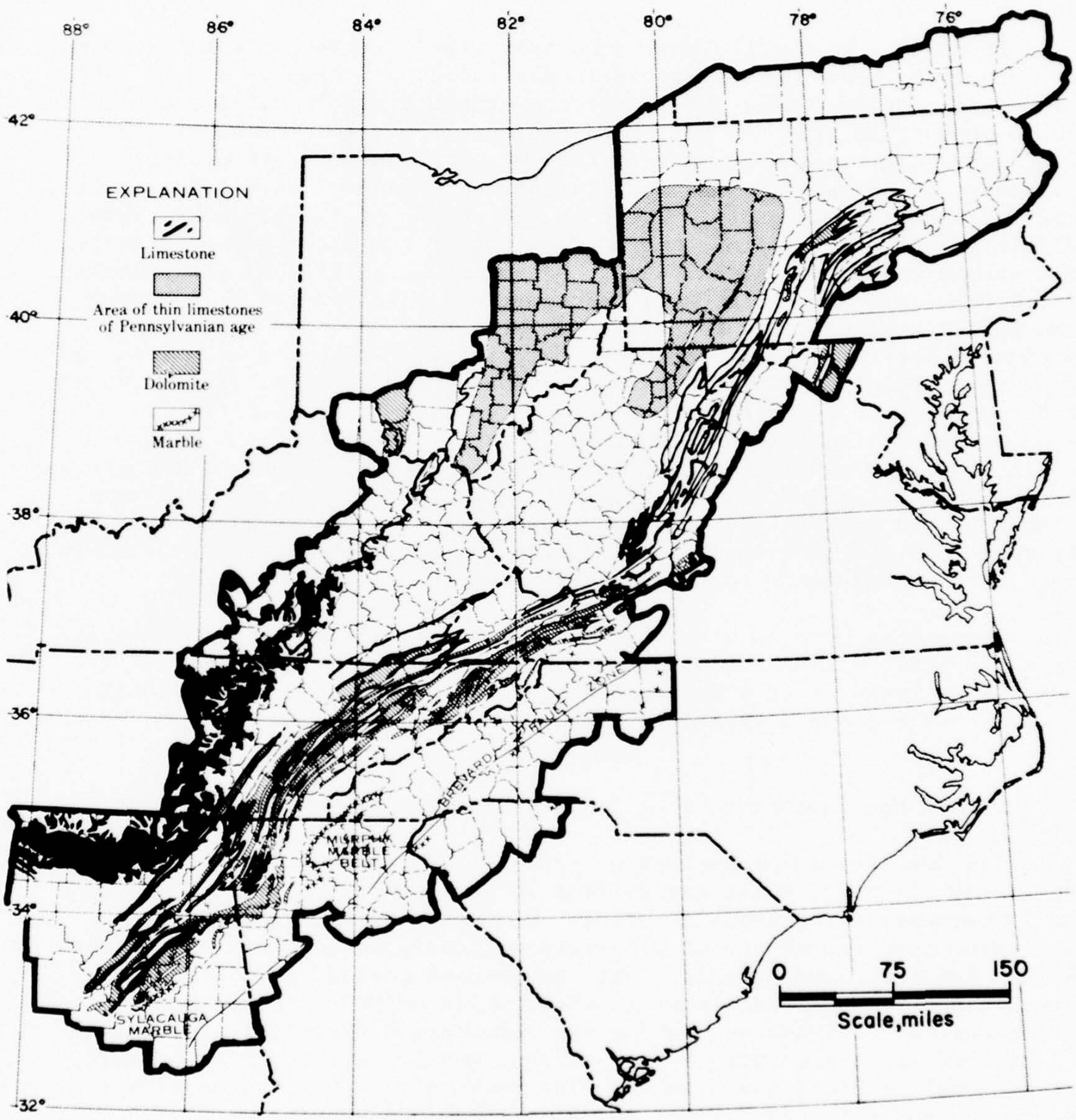

FIGURE 1 - 6. - Limestone, Dolomite, and Marble in the Appalachian Region.
(Source: Fig. 68, U.S. Geological Survey, Professional Paper 580, 1968)

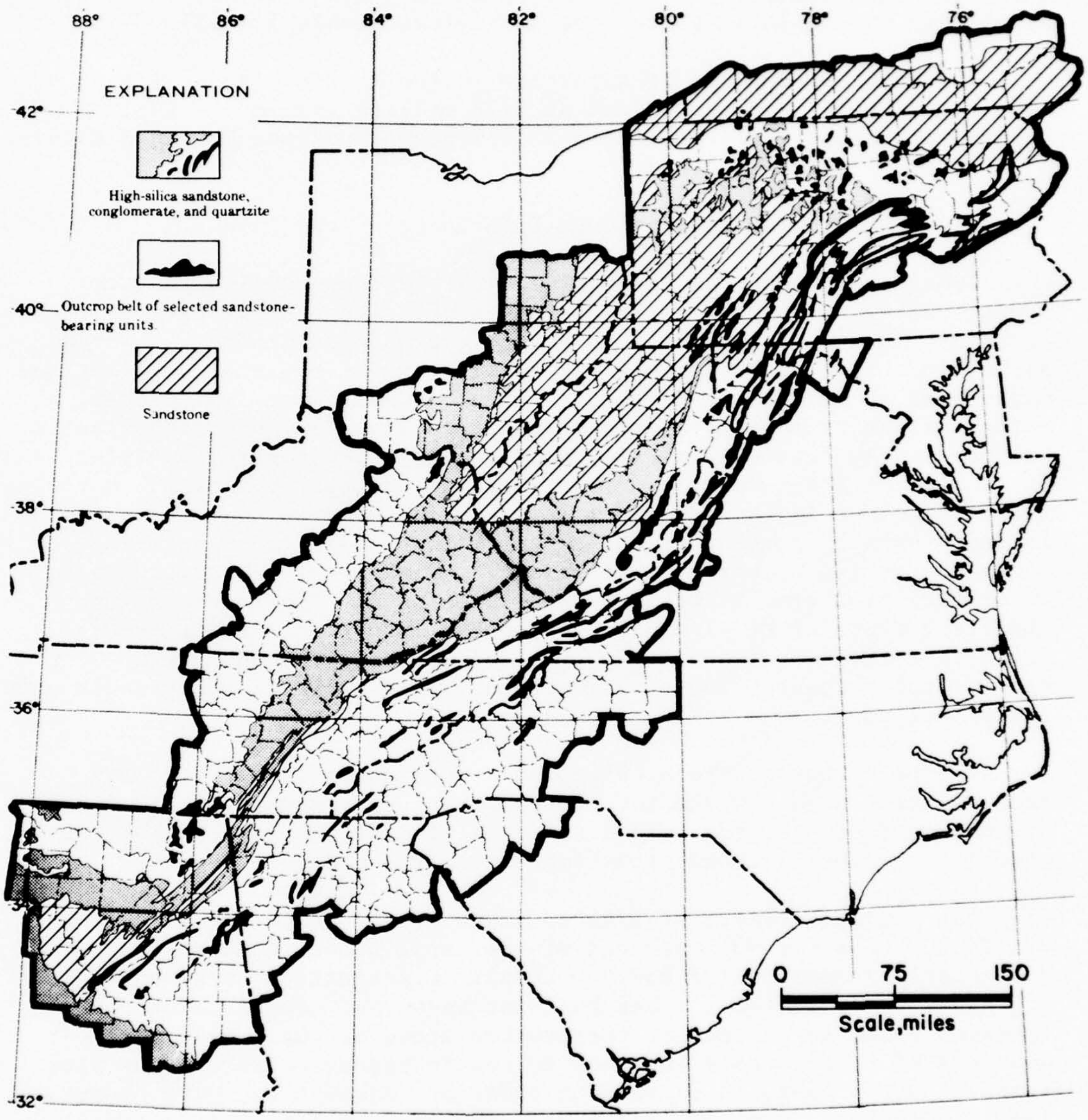

FIGURE 1 - 7. - Sandstone in the Appalachian Region.
(Adapted from Fig. 62, U.S. Geological Survey, Professional Paper 580, 1968)

respectively, for output and value. While stone (crushed and dimension) was produced in all the 10 subregions in 1965, five of these (in order of output: J, B, E, G, and F) accounted for almost 85 percent of the total tonnage (table 1 - 14). Most of the 546 mines or quarries in Appalachia were also in these five subregions (table 1 - 13).

The total production of all stone in the Appalachian Region in 1965 was 98 million tons, valued at $178 million (table 1 - 14), equivalent respectively to 12.5 and 14.9 percent of the National totals.

Major Uses and Economic Importance of the Industry

Appalachian stone is used largely by the construction industry, predominately as crushed material in various size classifications for aggregates and road material and as the dimensioned products--blocks, slabs, and other shapes to satisfy requirements for use as building and monumental stone, paving blocks, curbing, and flagging. Limestone, either as the crushed rock or calcined into lime, has additional applications in the chemical, metallurgical, glass, and paper industries. It is also used for water treatment and agricultural purposes. Moreover, limestone is the principal raw material used in cement manufacture--over 80 percent of the cement kiln feed is low-magnesian limestone or its calcareous equivalent. Quicklime (high-calcium and dolomitic) is thermally derived from limestones. Appalachia is an important producer of glass sand and other industrial sands, much of which is derived from sandstone, including quartzite and quartz. For statistical purposes, industrial silica is classified largely under sand and gravel uses.

Virtually the entire Appalachian stone output is marketed for crushed stone uses. While the production of dimension stone in terms of tonnage is small, the output value is significant, accounting for about 14 percent of total stone value over the past two decades.

The regional output of crushed stone of all varieties in 1965 was 97,324,000 tons, or 99.5 percent of the total stone (crushed and dimension) production (97,852,000 tons). Construction uses--concrete aggregate and roadstone, other building uses, and cement manufacture--consumed about 80 percent of the crushed stone output. Over three-quarters of this tonnage was used as coarse aggregate in various size ranges. Other uses, in decreasing order of consumption, were fluxstone, lime manufacture, agricultural stone, railroad ballast, and refractories. These markets consumed about 15 percent of the crushed stone output. Miscellaneous and unspecified uses accounted for the remaining 5 percent.

The importance of stone in the Appalachian mineral economy is only partly indicated by its share of 6.6 percent of the total regional mineral production value of $2,713 million (1958 constant dollars) in

TABLE 1 - 14. - Stone production and value in the Appalachian Region, 1961-65

Subregion	1961	1962	1963	1964	1965
Production (thousand short tons)					
A	864	1,346	1,538	1,561	1,509
B	12,016	12,862	15,700	14,709	16,836
C	W	W	W	W	W
D	5,704	6,801	6,175	5,954	6,194
E	13,063	12,568	12,638	17,786	16,414
F	6,503	7,734	7,555	8,175	9,321
G	9,204	9,851	11,030	11,467	12,213
H	W	W	W	W	W
I	3,135	3,456	3,657	3,274	3,439
J	21,955	23,042	24,328	24,804	28,014
Undistributed	4,572	5,507	5,903	4,162	3,912
Total	77,016	83,167	88,524	91,892	97,852
Value in thousand 1958 constant dollars					
A	$2,327	$2,858	$3,170	$3,394	$3,345
B	21,265	23,779	24,915	25,418	30,080
C	W	W	W	W	W
D	9,196	10,552	9,958	9,738	10,222
E	32,185	31,910	35,751	42,002	45,732
F	11,354	13,465	13,519	13,352	15,935
G	17,542	18,182	20,358	21,209	23,093
H	W	W	W	W	W
I	5,165	5,471	6,681	5,684	5,611
J	32,982	33,260	34,999	35,738	38,458
Undistributed	4,846	7,881	6,457	6,660	6,059
Total	136,862	147,358	155,808	163,195	178,535
Distribution of production (percent)					
A	1	2	2	2	2
B	16	15	18	16	17
C	W	W	W	W	W
D	7	8	7	7	6
E	17	15	14	19	17
F	8	9	9	9	10
G	12	12	12	12	12
H	W	W	W	W	W
I	4	4	4	4	3
J	29	28	28	27	29
Undistributed	6	7	6	4	4
Total	100	100	100	100	100
Distribution of value (percent)					
A	2	2	2	2	2
B	16	16	16	16	17
C	W	W	W	W	W
D	7	7	6	6	6
E	23	22	23	26	26
F	8	9	9	9	9
G	13	12	13	13	13
H	W	W	W	W	W
I	4	4	4	3	3
J	24	23	23	22	21
Undistributed	3	5	4	3	3
Total	100	100	100	100	100

W Withheld to avoid disclosing individual company confidential data; included with "Undistributed".

1965. After bituminous coal, stone is the most valuable mineral produced in Appalachia. Even cement, the commodity next in value, is a manufactured product derived largely from stone (low-magnesian limestone). Stone and cement are almost indispensable building materials supplying the construction industry, the only mineral-related industry in Appalachia for which the Office of Business Economics (OBE) predicts gains in employment in all the 10 subregions to the year 2000.

Resource Potential

Resources of stone, per se, are immense and reserves are virtually limitless. Rocks suitable for preparation of construction materials are abundant and widespread in Appalachia and constitute a vital resource for present and future industrialization and urbanization. The carbonate rocks; limestone, dolomite, and marble; and sandstones, including quartzite and quartz, are the most important stones mined or quarried in Appalachia. Together they accounted for almost 93 percent of all stone produced in the Region over the past two decades. In addition to supplying the bulk of crushed stone for construction aggregate, and also most of the dimension stone, they are indispensable sources of raw material for other applications - limestones for cement and lime manufacture and fluxing use, and sandstones for glass sand and other industrial silica. The distribution of limestones and sandstones in Appalachia is shown in figures 1 - 6 and 1 - 7. In general, and considering most uses, resources of both limestones and sandstones are ample for the foreseeable future. The other stone varieties - basalt and miscellaneous types - comprise only a minor portion of the total stone output and are mainly of local importance; reserves are adequate. However, availability of metallurgical or lime-and-chemical grade stone (limestone or dolomite) is geographically restricted and the demand continues to increase. Consequently, this situation calls for discovery and development of new deposits and mining or quarrying from deposits heretofore neglected because of relative inaccessibility and distance from consuming centers.

Problems and Outlook

Continuing problems of stone production are those related to costs of mining, handling, and processing. Improving the efficiency of drilling and blasting operations are problems that concern both crushed and dimension stone production. Also common to both stone types are problems involving removal of overburden and the growing insistence upon land rehabilitation and the control of noise, air and water pollution, and other annoyances or undesirable conditions to avoid restrictive zoning legislation. Loss of production sites because of zoning in urban and suburban areas is a growing problem. However, adequate sources of supply will remain although probably less accessible and at progressively greater distances from consumption centers.

The ever-present competition from alternate construction or building materials is a factor tending to limit production of stone in some areas. Crushed stone competes with sand and gravel and blast furnace slag in the construction aggregate market. Dimension stone competes with alternate building materials such as glass, metals, ceramic tile, brick, plastic panels, and other facing materials in situations where choice favors an alternate, or in areas where an alternate is cheaper.

Accelerated highway, industrial, and housing construction in Appalachia are and will continue to be major factors in increasing the demand for crushed and dimension stone. Stone production will continue to grow along with the population and economy.

While the greatest growth in demand for stone will be in the expanding centers of population and industry, such as, Birmingham, Ala., and Pittsburgh, Pa., a rise in demand will be evident in all the subregions in Appalachia. Areas where unusually large local demands may be expected are the Piedmont Belt of Alabama, the Carolinas, and Georgia where the economy is showing rapid growth, a response to which is an increasing influx of rural industrial facilities. The OBE predicts positive growth rates of population during the period from 1960-80 in all the 10 subregions with parallel growth in construction employment.

Projections for crushed and dimension stone production are shown in table 1 - 15. The growth rates for crushed and dimension stone conform to projections for 1975 published by the Bureau of Mines.

TABLE 1 - 15. - Projected stone production in the Appalachian Region, 1980 and 2000

Year	Annual rate of growth, percent	Production, thousand short tons
	Crushed stone	
1964	4.3	91,706
1980	4.3	185,130
2000	4.3	429,630
	Dimension stone	
1964	5.4	340
1980	5.4	787
2000	5.4	2,281

Sand and Gravel

Geographic Distribution and Structure of the Industry

The sand and gravel industry is fairly well distributed throughout the Appalachian Region. In 1965, sand and gravel was produced at 297 operations located principally in the northern portion of Appalachia. Output is currently reported in all subregions except H, which consists of 18 counties in eastern Kentucky. Most operations are located in Subregions G (77), F (69), and B (62). There are two operations in Subregion I and four in Subregion C.

The industry of the Region consists chiefly of companies or owners which operate single unit plants, pits, or dredges. Operations range from the small independent bank-run pits to large volume, automated processing plants. Facilities range from large stationary plants having complex processing to small crushing and screening plants that can be moved within hours to new locations. Some companies operate more than one plant where the market or demand warrants. Because of sand and gravel's ubiquitous nature, low price, and great bulk, plants and operations are located primarily near the market area, usually within 25 to 30 miles of the point of consumption. Some special grades of sand which are obtained from high quality deposits or processed to rigid specifications are shipped greater distances to consumers.

Most sand and gravel is shipped short distances to consumers by truck. Railroad shipments are chiefly higher priced industrial sands; these materials may move hundreds of miles to points outside the Appalachian Region. The sand and gravel produced in the Appalachian area is sold chiefly in the open market. Some of the output is captive in that it is used by the producer for preparing ready-mix concrete, concrete masonry units, or bituminous mix.

Sand and gravel output in any particular locality is determined primarily by the current rate of construction activity within that marketing area, because the material cannot be shipped economically for any great distance and also must contend with competitive materials such as crushed stone and slag.

Current Regional Production and Relationship to National Production

For the past two decades, sand and gravel production in Appalachia has increased steadily, nearly threefold from 1945 to 1965. National output increased nearly fourfold in the same period. However, the Region's share of the United States total has declined from an average of 6.5 percent in 1945-49 to an average of 3.7 percent in 1960-64. As indicated in table 1 - 16, production of sand and gravel increased significantly during the 1961-65 period and accounted for 2 percent of

Appalachia's total mineral valuation. Output in 1965 totaled 35.4 million tons, valued at $55.4 million (1958 constant dollars).

The Appalachian Region is an important source for the production of industrial sands. In 1964, industrial sand output totaled 3.5 million tons and accounted for 15 percent of National production. Industrial sand production was centered principally in four counties in Subregion B.

Appalachia's output of construction sand totaled 13.7 million tons and construction and miscellaneous gravel totaled 13.9 million tons. The Region's sand and gravel output in 1964 accounted for 3.6 percent of the United States total of 868.8 million tons.

Currently, sand and gravel production in Appalachia is centered mainly in Subregions B, F, and G. In 1961-65, these three Subregions supplied about 75 percent of the tonnage and 81 percent of the value of sand and gravel production in Appalachia. Although Subregion F ranks first in tonnage, supplying 59 percent more tonnage than Subregion B, the latter Subregion was the leading area in terms of value, because of the production of higher priced industrial sands. Generally, the sand and gravel production in Subregions B, F, and G comes from large volume operations at sites having deposits which can be mined or dredged economically and which are near major metropolitan areas. Operations in the other subregions are less numerous and are situated in the less urbanized areas of Appalachia.

Major Uses and Economic Importance of the Industry

Sand and gravel produced in Appalachia is used primarily in construction applications such as concrete aggregate, roadstone, railroad ballast, and as fill material. Natural and ground industrial sand is marketed for a variety of uses including glass manufacturing, grinding and polishing, molding, and traction sand. The 1964 survey of sand and gravel uses in Appalachia indicated that 89 percent of the material was used in construction and the remainder was classified as industrial sand.

In terms of tonnage, construction sand and gravel are the most important uses. In structural applications, the material is used in mortar, plaster, and concrete aggregate. Some is used by producing companies for manufacturing concrete masonry units pipe, and other concrete products. In road construction and maintenance, sand and gravel is used in all phases from subbase material to final topping either as concrete aggregate or bituminous mix. Some gravel is marketed as ballast in the maintenance of railroad tracks.

TABLE 1 - 16. - Sand and gravel production and value in the Appalachian Region, 1961-65

Subregion	1961	1962	1963	1964	1965
Production (thousand short tons)					
A	969	1,099	1,171	1,547	2,076
B	5,894	5,543	6,060	6,539	7,350
C	W	W	W	W	W
D	1,353	1,789	1,305	1,213	1,078
E	1,552	1,081	1,405	1,212	1,584
F	7,887	9,350	9,246	10,466	11,665
G	5,981	6,249	6,759	6,062	7,632
I	W	W	W	W	W
J	3,054	4,239	3,433	3,866	3,848
Undistributed	190	131	245	148	158
Total	26,880	29,481	29,624	31,053	35,391
Value in thousand 1958 constant dollars					
A	1,327	1,426	1,481	1,967	2,645
B	13,699	13,712	14,492	15,092	16,994
C	W	W	W	W	W
D	1,041	1,504	1,144	1,051	876
E	1,464	1,025	1,400	1,308	1,744
F	11,026	12,949	13,550	14,554	16,137
G	8,686	9,634	9,911	9,580	11,549
I	W	W	W	W	W
J	3,772	4,724	4,468	5,019	5,262
Undistributed	249	251	381	246	232
Total	41,264	45,225	46,827	48,817	55,439
Distribution of production (percent)					
A	4	4	4	4	6
B	22	19	20	21	21
C	W	W	W	W	W
D	5	6	4	4	3
E	6	4	5	4	4
F	29	32	31	34	33
G	22	21	23	20	22
I	W	W	W	W	W
J	11	14	12	13	11
Undistributed	1	(1/)	1	(1/)	(1/)
Total	100	100	100	100	100
Distribution of value (percent)					
A	3	3	3	4	5
B	33	30	31	31	31
C	W	W	W	W	W
D	2	3	2	2	2
E	4	2	3	3	3
F	27	29	29	30	29
G	21	21	21	20	21
I	W	W	W	W	W
J	9	11	10	10	9
Undistributed	1	1	1	(1/)	(1/)
Total	100	100	100	100	100

W Withheld to avoid disclosing individual company confidential data.
1/ Less than .05 percent.

Higher priced industrial sands produced in Appalachia also have numerous markets. Stringent specifications by industrial sand users require care in processing, especially as to grain size and chemical composition. Most industrial sands must be high in silica content. The glass industry is one of the most important users of industrial sand, requiring material that is free of iron oxide. Molding sand produced in the Region is used by foundries for lining molds and castings. Engine sand is used to provide traction under locomotives and street cars and to remove soot from oil burning locomotives. Grinding and polishing sand is used in abrasive applications such as sandpaper manufacturing, sand-blasting, stone sawing, glass grinding and polishing, and in sweeping compounds. There are many minor uses for silica sand such as in ceramics, for manufacturing sodium silicate, lining of furnaces, potter's sand, and in nurseries, aquariums, sand boxes, playgrounds, and golf courses. Ground sand is marketed for a variety of applications such as a filler in paint, asphalt, tile, plastic, rubber, and many other products.

Construction sand and gravel is produced throughout the Region and is essential to the regional and National economy as an integral part of the construction industry. Because of its bulky nature, low value, and well distributed sources of supply, construction sand and gravel is produced and consumed locally. In contrast, industrial sands, because of their unique specifications and high unit values, are shipped to a larger marketing area both within and outside the Region.

According to the 1964 sand and gravel survey, 20.5 million tons were shipped to consumers by trucks, 3.7 million tons by railroad and 6.4 million tons by water craft. Most of the shipments within the Region were by truck. Higher priced industrial sands were shipped principally by railroad.

Resource Potential

Widespread, large deposits of sand and gravel are available in Appalachia and are generally adequate for the foreseeable future. The distribution of sand and gravel deposits in Appalachia is shown in figure 1 - 8. The map shows several areas grouped into three general categories according to relative abundance. Most of the sand and gravel deposits in Appalachia are classified as fluvial, glacial, or residual. Of the three, fluvial deposits are the most extensively exploited source of sand and gravel and consist of deposits in rivers, perched benches, terraces, and glacial outwashes of former rivers. Sand and gravel is obtained from the Susquehanna, Monongahela, Allegheny, Ohio, and Potomac Rivers and their major tributaries in northern Appalachia (Subregions A, B, F, and G). In southern Appalachia, parts of the Tennessee River and its tributaries (Subregions D, E, and J) yield sand and gravel. Fluvial deposits in the Piedmont and Blue Ridge provinces (eastern and southern edges of Appalachia) are numerous, but

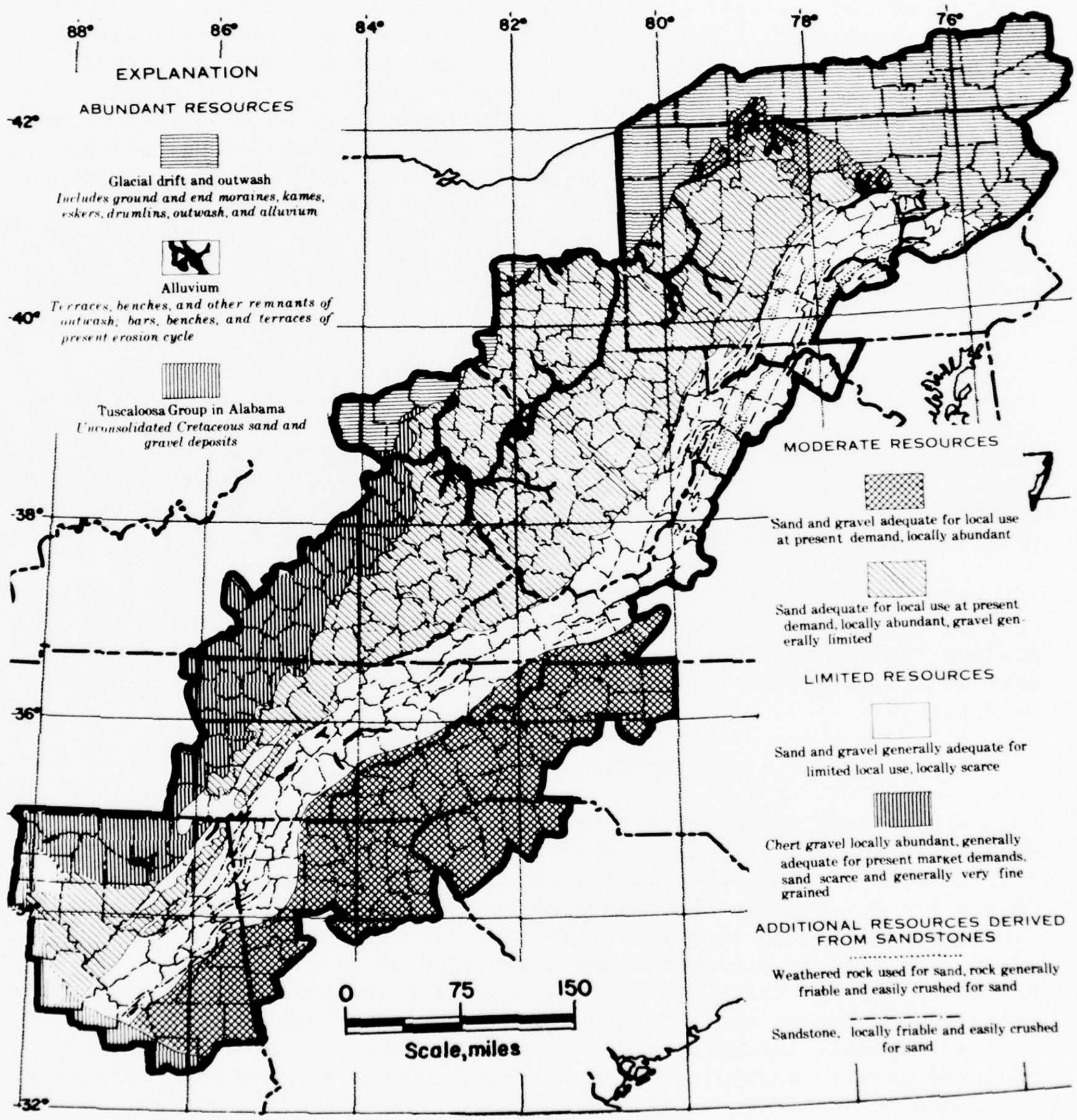

FIGURE 1 - 8. - Sand and Gravel Resources in the Appalachian Region.
(Source: Fig. 69, U.S. Geological Survey, Professional Paper 580, 1968)

vary in size and are confined chiefly to river floodplains. In central Appalachia (Appalachian Plateau province) large deposits of sand and gravel and limited resources of gravel occur in localities that are largely confined to small floodplains and river channels along the major drainage systems. The Valley and Ridge province in the southern and eastern part of the Region contains the smallest resources of sand and gravel.

Large glacial sand and gravel deposits are abundant in the northern part of Appalachia (Subregions B, F, and G). These deposits, as well as many large fluvial deposits and numerous small deposits, constitute substantial resources of sand and gravel.

Residual deposits consist of unconsolidated or colluvial deposits of sand derived from the weathering of sandstone. These friable sandstone deposits are an important source of good quality sand in the Region and have been developed in parts of Pennsylvania, West Virginia, northern Alabama, and Tennessee.

Problems and Outlook

Many technical and economic problems are encountered by the Region's sand and gravel industry. Although Appalachia is endowed with large and abundant resources, the deposits in some areas are erratic, creating difficulties in production planning. More systematic evaluation of these deposits is needed, not only for determining quantity and quality of reserves, but to aid in exploitation of the more valuable deposits before urbanization causes them to be forever withdrawn from exploitation. In areas deficient in sand and gravel resources, competitive material such as crushed stone, slag, and expanded clay and shale aggregate can be marketed and utilized. More effective planning is required by the industry because of the rapid growth and shift of population, major changes in construction and industrial sand specifications, and restrictive zoning legislation. A constant problem is the necessity of an adequate water supply, with the accompanying issue of waste water disposal.

Opportunities for growth in the sand and gravel industry of Appalachia will be localized. New plants will be set up in rural areas to handle the demand for highway construction material, and near urban areas to meet the increasing demand for building sand and gravel used in housing and other construction activity. Although many economic and technical problems face the industry, it is expected that an increasing amount of sand and gravel will be produced and consumed in Appalachia. Projections for sand and gravel production in Appalachia are listed in table 1 - 17. The 3.3 percent average annual growth rate projected for the 1964-80 and 1980-2000 periods is based upon forecasts of increases in income, population, and housing, and accelerated Federal and State highway building programs in Appalachia.

TABLE 1 - 17. - Projected sand and gravel production in the Appalachian Region, 1980 and 2000

Year	Annual rate of growth, percent	Production, thousand short tons
1964	3.3	31,053
1980	3.3	52,990
2000	3.3	101,440

As a result of population increases expected in the next 15 to 20 years, demand for housing and construction of all types will continue to grow. More plants will be needed for this projected demand, but competition will become sharper as more producers of sand and gravel and competitive materials enter the market. As specifications become more rigid, established producers will have to overcome processing problems to remain competitive or abandon operations. New producers must study every phase of production and marketing to overcome the high volume, low unit value, and low profit margin aspects of the business. Demand for higher priced specialty sands is expected to increase. Research on new applications for chemical and industrial products derived from silica, and expanded use as a filler should create new markets. The continuing and expected growth of the Appalachia bituminous coal industry should increase demand for sand used as separation media in coal preparation plants. Suitable sand and gravel deposits near urban areas are becoming less plentiful, but with greater and more widespread use of improved portable plants situated nearer the market, good quality construction material would be available at lower delivered prices, by reducing hauling distances.

In summation, the outlook for Appalachia's sand and gravel industry is optimistic with no major obstacles or insurmountable problems anticipated.

Clays

Geographic Distribution and Structure of the Industry

Clay (including shale) is widely distributed throughout the Appalachian Region; clay mining is carried on in all of the States within the Region. In 1965, clay was mined in 245 locations. Mining activity is concentrated in districts having favorable combinations of suitable deposits and proximity to markets.

Minerals recognized as clays are classified by the Bureau of Mines for statistical reporting into six types: kaolin, ball clay, fire clay, bentonite, fuller's earth, and miscellaneous clay and shale. These

minerals have common characteristics of a very fine crystalline structure, plastic when sufficiently pulverized and wetted, having varying degrees of rigidity when dry, vitreous when fired at a sufficiently high temperature, and composed principally of hydrous aluminum silicates. Presence of other minerals and impurities in the clay alter its properties and determine the type of a deposit and range of usefulness.

In the Appalachian Region, three types of clay are produced; kaolin, fire clay, and miscellaneous clay and shale. Kaolin deposits usually occur near the eastern margin of the Region from Alabama to Pennsylvania. Only a few deposits are mined, and kaolin is a minor factor in the total Appalachian clay industry.

Fire clay deposits are widespread, particularly as underclays associated with coalbeds, but much of the production is concentrated in districts where deposits are close to markets (fig. 1 - 9). In 1965, fire clay was produced at 116 mines in Alabama, Kentucky, Ohio, and Pennsylvania.

Miscellaneous clay and shale deposits are extensive and widespread. In 1965, 123 mines were operated in Appalachia, and at least one mine was operated in each State. In Subregion G, there were 51 mines, and four other Subregions (B, E, F, and J) each contained more than 10 mines.

Kaolin was produced in 1965 at six mines in Alabama, Georgia, North Carolina, and Pennsylvania.

Clay mining in Appalachia is carried on largely by consuming manufacturers or companies controlled by them. Most miscellaneous clay and shale is mined by clay-products producers who operate one or more mines to feed a single processing or manufacturing plant. The dominant pattern for the production of fire clay is that of large multimine manufacturers of refractory products who blend the output from several mines as needed to make a range of refractory products having consistent properties.

Marketing areas for clays are usually determined by the captive relationship of the mines to the processing plant. Fire clay deposits are usually localized, and it is feasible to haul the clay long distances for processing.

Current Regional Production and Relationship to National Production

Appalachia is important to the clay consuming industries. A survey of the 1945-64 period disclosed that the Region supplied more than 40 percent of the fire clay and 12 percent of the miscellaneous clay and shale produced in the United States.

In 1964, the Region's output of fire clay totaled 3.6 million tons valued at $20.2 million (1958 constant dollars); miscellaneous clay and

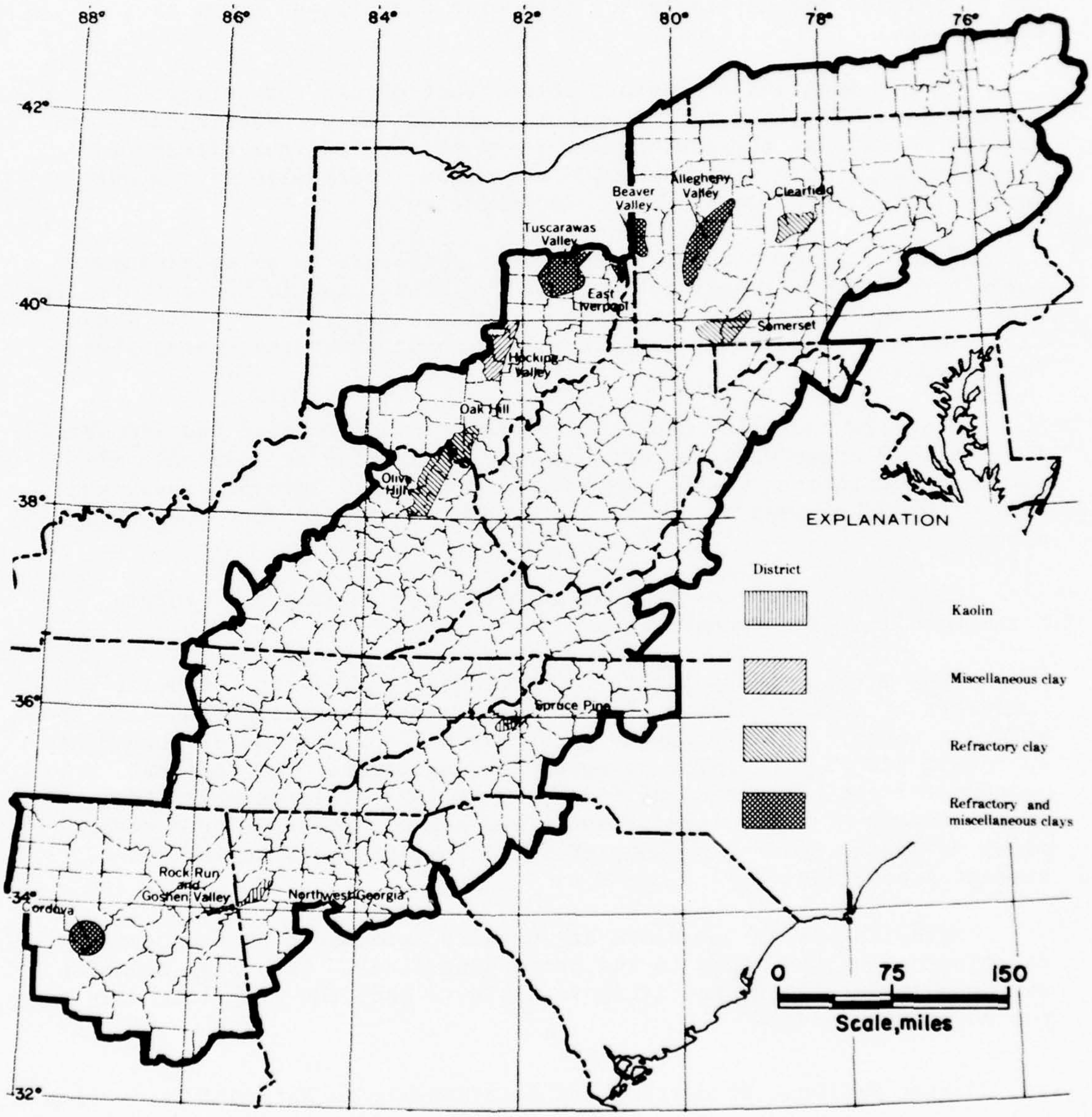

FIGURE 1 - 9. - Principal Clay Mining Districts in the Appalachian Region.
(Source: Fig. 59, U.S. Geological Survey, Professional Paper 580, 1968)

shale totaled 4.5 million tons worth $5.9 million, and kaolin totaled 42,000 tons worth $443,000.

Fire clay production in Appalachia declined from 1957 to 1962, but since that time a modest growth has occurred. National fire clay production has shown similar trends. Over the past two decades the unit value (1958 constant dollars) of Appalachian fire clay has risen faster than the National average. As a result, the value of Appalachian fire clay has continued to be about 52 percent of the National total, although the Region's production has declined from 49 percent of the National total in 1945-49 to 42 percent in 1960-64.

Miscellaneous clay and shale production in Appalachia has maintained pace with the National growth. Appalachia accounted for 12.3 percent of production in 1945-49; and 12.6 percent of production for 1960-64. During this 20-year period the production in Appalachia more than doubled.

Kaolin produced in Appalachia accounts for less than 1 percent of regional clay and shale production and about 1 percent of National kaolin production. The other clay types, ball clay, bentonite, and fuller's earth, are not produced in Appalachia.

Total regional production of all clays in 1965 amounted to 8.9 million tons valued at $30 million (table 1 - 18), equivalent respectively to 16.2 and 15.6 percent of the National totals. The National statistics are influenced greatly by the high unit values of kaolin and the other types of clay not produced in Appalachia. Kaolin, ball clay, bentonite, and fuller's earth together accounted for only 12 percent of the clay produced in the United States in 1965, but this group of clay types represented 55 percent of the total value.

Major Uses and Economic Importance of the Industry

Appalachian clay is used chiefly in manufacturing fired clay products. The remainder is consumed largely in manufacturing cement or lightweight aggregate. The survey of 1964 indicated that fired products consumed 74 percent of the clay products, 54 percent in heavy clay products and 20 percent in refractory products. Clay for feedstock accounted for 19 percent of the total: 10 percent for cement making, and 9 percent for manufacturing lightweight aggregates. About 5 percent of the total was used unfired for foundry purposes.

Clays are important to the mineral economy of Appalachia. In 1965, clays accounted for 1.1 percent of the total mineral value produced in the Appalachian Region; excluding fuels, the percentage was 5.7 percent. The Region annually produces more than 40 percent of the fire clay produced in the United States, and supplies more than 20 percent of the market for clay refractories. These clay refractory

TABLE 1 - 18. - Clay production and value in the Appalachian Region, 1961-65

Subregion	1961	1962	1963	1964	1965
Production (thousand short tons)					
A	W	300	W	180	209
B	686	633	657	769	819
C	W	W	W	W	W
D	W	W	W	W	W
E	1,176	1,072	1,047	1,293	1,684
F	2,003	1,860	2,122	2,222	2,325
G	2,368	2,147	2,131	2,119	2,380
H	W	W	W	W	W
I	W	W	W	W	W
J	981	1,003	1,077	1,005	929
Undistributed	779	547	835	564	586
Total	7,993	7,562	7,869	8,152	8,932
Value in thousand 1958 constant dollars					
A	W	244	W	165	190
B	2,290	2,022	2,215	2,505	2,741
C	W	W	W	W	W
D	W	W	W	W	W
E	1,534	1,438	2,385	3,333	4,347
F	12,485	10,760	11,831	12,365	13,693
G	8,124	6,798	7,195	6,753	7,943
H	W	W	W	W	W
I	W	W	W	W	W
J	716	926	934	939	887
Undistributed	666	502	692	521	581
Total	25,815	22,690	25,252	26,581	30,382
Distribution of production (percent)					
A	W	4	W	2	2
B	9	8	8	10	9
C	W	W	W	W	W
D	W	W	W	W	W
E	15	14	13	16	19
F	25	25	27	27	26
G	30	28	27	26	27
H	W	W	W	W	W
I	W	W	W	W	W
J	12	13	14	12	10
Undistributed	9	8	11	7	7
Total	100	100	100	100	100
Distribution of value (percent)					
A	W	1	W	1	1
B	9	9	9	9	9
C	W	W	W	W	W
D	W	W	W	W	W
E	6	6	9	13	14
F	48	48	47	46	45
G	31	30	28	25	26
H	W	W	W	W	W
I	W	W	W	W	W
J	3	4	4	4	3
Undistributed	3	2	3	2	2
Total	100	100	100	100	100

W Withheld to avoid disclosing individual company confidential data; included with "Undistributed".

products range from foundry clay valued at about $10 per ton to insulating brick and shapes worth about $160 per ton. An average value for clay refractories is difficult to ascertain because of the wide variety of products manufactured. The value of clay refractories is approximately $40 per ton of clay mined; in 1964 mining fire clay was a $72 million industry.

Heavy clay products constitute an important segment of the mineral-based economy. This category includes the structural clay products such as common and face brick, vitrified sewer pipe, flue liners, and a variety of tile forms. Appalachia provided 18 percent of National requirements for heavy clay products in 1965, and the value of these products totaled $104 million, or about $25 per ton of clay mined.

The value to Appalachia of clay mining and manufacturing is about $200 million annually, $28 million for the clay produced, $104 million for the heavy clay products, and $72 million for fire clay refractory products. Heavy clay products and clay refractories are shipped to markets both in and outside of the Region.

Resource Potential

Deposits of fire clay suitable for use in low- and moderate-heat duty refractory products and heavy clay products are large, but high-quality clay for high-heat duty products is limited. Resources of miscellaneous clay and shale are ample.

Clays for high-heat duty products occur chiefly in the Olive Hill district, Ky., and Clearfield and Somerset Counties, Pa. Some of the accessible high-grade deposits have been depleted.

Problems and Outlook

Future demands for Appalachian clays can be expected to increase at a rate lower than the Region's growth in manufacturing. Growth will be distributed unevenly, both geographically and with respect to the type of market. Markets for building products should grow primarily in response to population growth; increased volume of construction per capita may result from trends to larger houses and to more commercial and institutional construction. Heavy clay products, which are made from miscellaneous clay and shale, will share in this market. Increased competition is expected from building material substitutes, particularly metals and plastics.

Fire clay markets are expected to decline in importance and in volume, reaching a low point in 1980. Clay refractories will continue to be displaced in steelmaking furnaces by basic brick, and by high-alumina brick in heat exchangers and other furnaces. Markets for heavy

clay products will grow slowly, but a rapid decline in refractory markets for fire clay products is anticipated.

Projections for miscellaneous clay and shale and for fire clay are listed in table 1 - 19. The 3.3 percent rate projected for clay

TABLE 1 - 19. - Projected clay production in the Appalachian Region, 1980 and 2000

Year	Annual rate of growth, percent	Production, thousand short tons
	Miscellaneous clay and shale	
1964	3.3	4,488
1980	3.3	8,100
2000	3.3	15,500
	Fire clay	
1964	-1.1	3,622
1980	-1.1	3,100
2000	3.3	4,800

production for the 1964-80 period conforms to a similar projection for 1975, published by the Bureau of Mines. The 1964-80 projection is believed to be consistent with the growth of 1.5 percent in employment for the 1964-80 period projected by the Office of Business Economics (OBE). Miscellaneous clay production for 1980-2000 is also 3.3 percent, a continuation of the 1960-80 pattern. The 1980-2000 projection is believed to be consistent with the OBE construction employment projection of 1.3 percent.

Projections of fire clay production are complicated by a rapid decline in the clay refractories market. Refractories have accounted historically for about half of the fire clay output in the Region. The other half of the fire clay production has been used for heavy clay products and unfired foundry refractories. Fire clay production is expected to decline until the refractory market becomes stable about 1980. After 1980, production will increase to satisfy the steadily growing demand for heavy clay products.

Other Nonmetals

Geographic Distribution and Structure of the Industry

"Other nonmetals" in this report include nonmetallic minerals, other than clays, sand and gravel, and stone that are produced in

Appalachia. Except for cement and lime, which are mineral-derived manufactured commodities, and gemstones, other nonmetals are generally limited in geographic distribution, and production of most commodities is confined either to one or a relatively few water subregions.

In 1965, production of other nonmetallic minerals in Appalachia included the following in decreasing order of output value (the number in parentheses following each commodity is the number of subregions from which output was reported): Cement (6), lime (5), salt (3), pyrites (1), feldspar (2), barite (3), gypsum (2), asphalt (1), mica (1), talc (2), olivine (1), peat (3), abrasives (2), iron ore pigment material (3), potassium salts (1), and asbestos (1). Data on gemstone production are not available by subregions. The total value of other nonmetals was less than one-tenth of the total value of all mineral production in Appalachia (2,713 million 1958 constant dollars in 1965). Cement and lime accounted for most of the value and the remaining 15 commodities accounted for less than 2 percent of the total value of Appalachian mineral production. A discussion of each commodity follows.

Major "Other" Nonmetals

Barite

The principal source of barium and barium compounds is the mineral barite ($BaSO_4$). Witherite ($BaCO_3$) is a minor ore of barium. Barite is abundant and widespread nationally.

In 1965, total domestic production was 852,000 tons valued at $10.2 million (current dollars) and imports were 712,000 tons of crude barite valued at $5.6 million (current dollars) and 470 tons ground barite valued at $8,600. Witherite imports were 2,600 tons valued at $113,000.

Appalachian production is from Subregions D, E, and J. In 1964, Bartow County, Ga., Subregion E, reported 109,000 tons valued at $2 million (current dollars) which placed Georgia third in rank with 13 percent of the National total. Georgia data are company confidential for 1965 and are not available. Tennessee ranked fifth nationally in 1965 with reported production of 30,532 tons valued at $442,000 (current dollars); 4 percent of the National total. Tennessee production was from Loudon and McMinn Counties, Subregion J. South Carolina output in 1965 was from Cherokee County, Subregion D, and was less than that of Tennessee. Only a few operators account for Appalachian barite production. In Bartow County, Ga., there are two principal operators; in Loudon County, Tenn., one; in McMinn County, Tenn., one company operates three mines; and in Cherokee County, S. C., one mine is in operation.

Because barite has a high specific gravity (4.5) and is chemically inert, most of the output is used by the oil and gas industry as a

weighting agent in well-drilling muds. Currently 90 to 95 percent of available barite is used in drilling mud. The glass industry uses about 5 percent crushed 16 to 20 mesh as a surface frothing flux on melts and also as an oxidizer and decolorizer. Fine-ground barite is used as a filler or extender in paint, ink, linoleum, rubber, and other materials. A small percentage is used by the chemical industry.

In 1958, the U.S. Geological Survey estimated the measured and indicated reserves to be 285 million tons of ore containing about 46 million tons of barite. The reserves are principally in Missouri and the southern Appalachian States. Subregions D, E, and J, have ample reserves. Barite is not on the list of strategic and critical materials to be acquired for the National stockpile.

Low cost water transportation allows imports to compete successfully in coastal areas with domestic production which is shipped by rail. Unless new uses for barite are developed, the outlook is for static production because the demand for drilling mud reflects the activity in oil and gas well drilling.

Cement

The production of cement is one of the most important mineral industries in Appalachia and one that has had a marked increase during the past several decades. From 1945 to 1965, shipments of portland and masonry cement increased over threefold in quantity and over twofold in value. Cement production was reported from six of the 10 water subregions in Appalachia (table 1 - 20) and cement is manufactured in the Appalachian parts of all the States except Kentucky.

Capacities of portland cement plants in Appalachia in 1965 ranged from a low of 950,000 barrels (376-pound barrels), to a high of 4,320,000 barrels; the average annual capacity was about 2,150,000 barrels or 404,000 short tons. Cement plants are largely units of multiplant and multi-interest corporations, having one or more plants in the Appalachian Region. The initial investment in a cement plant is from $5 to $10 per barrel of annual capacity.

The greatest number of plants and the largest production are near the industrial centers of Pittsburgh, Pa. (Subregion F), and Birmingham, Ala. (Subregion E). Of the 24 cement plants in Appalachia in 1965, three were in Subregion B, one in Subregion C, eight in Subregion E, five in Subregion F, two in Subregion G, and five in Subregion J. The combined annual capacity of these plants was about 52 million barrels of portland cement.

In 1965, cement plants in Appalachia marketed 47 million 376-pound barrels of cement, of which almost 90 percent was portland cement. Shipments of masonry cement accounted for most of the remainder; a small quantity of slag cement was also shipped. The regional cement output and value accounted for 12 percent of the National total.

TABLE 1 - 20. - Cement production and value in the Appalachian Region, 1961-65

Subregion	1961	1962	1963	1964	1965
Production (thousand 376-pound barrels)					
B	W	W	W	W	W
C	W	W	W	W	W
E	W	W	W	W	W
F	8,100	8,142	8,429	9,477	11,140
G	4,118	4,249	4,260	4,300	4,572
J	7,848	7,967	7,790	7,886	8,281
Undistributed	20,549	21,099	20,925	22,406	23,031
Total	40,615	41,457	41,404	44,069	47,024
Value in thousand 1958 constant dollars					
B	W	W	W	W	W
C	W	W	W	W	W
E	W	W	W	W	W
F	$27,156	$26,577	$27,391	$30,869	$35,409
G	14,035	14,002	14,297	14,093	14,980
J	24,636	25,265	24,663	24,740	25,825
Undistributed	66,373	68,618	66,312	70,151	72,590
Total	132,200	134,462	132,663	139,853	148,804
Distribution of production (percent)					
B	W	W	W	W	W
C	W	W	W	W	W
E	W	W	W	W	W
F	20	20	20	21	23
G	10	10	10	10	10
J	19	19	19	18	18
Undistributed	51	51	51	51	49
Total	100	100	100	100	100
Distribution of value (percent)					
B	W	W	W	W	W
C	W	W	W	W	W
E	W	W	W	W	W
F	20	20	21	22	24
G	11	10	11	10	10
J	19	19	18	18	17
Undistributed	50	51	50	50	49
Total	100	100	100	100	100

W Withheld to avoid disclosing individual company confidential data; included with "Undistributed".

The value of cement shipments in 1965 was $149 million (1958 constant dollars) or almost 5.5 percent of the total of all mineral production in the Appalachian Region, $2,713 million (1958 constant dollars). The Region is capable of producing all the cement for internal needs and exporting large quantities to contiguous areas. Shipments of cement to the construction industries are made in bulk and in containers (94-pound bags) by rail, truck, and barge. At least 60 percent of the shipments went to ready-mixed concrete companies and the remainder, in decreasing order of shipments, to highway and other contractors, concrete product manufacturers, and miscellaneous customers.

Cement manufacturing consumes significant quantities of mineral commodities (low magnesian limestone, shale or clay, silica, and other minerals). Over 80 percent of the raw material for the cement kiln feed is limestone or its calcareous equivalent. In 1965, an estimated 12 million tons of this raw material was produced in Appalachia largely in captive operations, for consumption in the Region's cement plants. In its ultimate application as concrete, large tonnages of mineral aggregates (sand and gravel, crushed stone, and slag) are also consumed.

Low magnesian limestones, the major raw material for cement manufacture, are widespread and abundant in Appalachia with the exception of the central part of the Appalachian Plateaus province, and the Piedmont province. Resources in the Region are ample not only to sustain the present demand by the cement industry but to supply any expansion in the future. Other cement raw materials (sand or sandstone, shale, and clay) are adequate to abundant in all parts of Appalachia. Fuels, especially coal, are in adequate supply for any foreseeable demand by the cement industry.

Overcapacity and accompanying price competition are the principal cement industry problems locally and nationally and they are likely to exist for the next several years. However, the long-range National prospects are favorable; predicted cement production by 1975 will exceed the present National capacity. The cement industry both nationally and in Appalachia will continue to expand in response to the growing need in highway, industrial, and housing construction resulting from population growth. However, as in the past, the cement industry in Appalachia will continue to compete for internal and external markets with plants on the periphery of the Region.

Feldspar

Feldspars are a group of rock-forming anhydrous silicate minerals containing aluminum and one or more of the elements, potassium, sodium, and calcium, in which one of the latter generally predominates. The minerals are common in igneous rocks. Deposits are widely distributed and feldspar has been produced in many States.

All Appalachian feldspar production was from Subregions D and J. North Carolina is the primary producing State, and in 1965 reported

279,000 tons of feldspar valued at $3.2 million (current dollars), which was 45 percent of the National production and 54 percent of the value. Most of North Carolina's feldspar production was from Madison, Mitchell, and Yancey Counties, all in Subregion J. Feldspar recovered from crushed granite screenings in Spartanburg County, S. C., accounted for all of South Carolina and Subregion D production in 1965.

There are adequate feldspar resources in Appalachia to provide for hundreds of years' production. In the Spruce Pine district (Mitchell County, N. C.) alone, reserves within 50 feet of the surface exceed 200 million tons.

In 1965, glass manufacture consumed about 56 percent of the National feldspar production; pottery, 30 percent; and enamel, 5 percent. Other uses are in scouring soaps and powders, floor sweeping compounds, dentures, electric welding rod coatings, grinding wheel binders, and soil conditioning.

Several factors affect feldspar production in Appalachia. First, the mineral composition of the mined ore requires beneficiation to fit the consumers specifications which include limits for potash, soda, and alumina, maximum iron contamination, color, fusion characteristics, and screen sizes. Consumers also demand uniformity from batch to batch. Second, transportation costs tend to limit the marketing area because manufacturers evaluate the contributing feldspar costs in finished products against other competing feldspathic materials. Third, there is competition by feldspathic materials such as Virginia aplite and Canadian nepheline syenite for ceramic and glass products. Plastics and metals for household food containers and for one-trip supermarket food containers compete with glass. The outlook is for projected growth in the industry because of technical know-how in beneficiation, and marketing skill to meet consumer demands.

Gypsum

Gypsum (hydrous calcium sulfate, $CaSO_4 . 2H_2O$) is variously known as alabaster, satin spar, selenite, rock gypsum, and gypsite. Gypsum is of major importance as a source of plaster because it loses three-fourths of its water of crystallization at moderate heat (between 250° and 400° F) and in this form, upon the addition of water, becomes plastic but sets into a rigid mass.

Total domestic crude production in 1965 was 10.0 million tons valued at $37.4 million (current dollars). Ten States share 75 percent of the domestic output and 10 additional States share 25 percent. Imports in 1965 were 5.9 million tons valued at $11.8 million (current dollars) of which Canada's share was slightly over 80 percent of quantity and value. The Nation's gypsum industry is dominated by 10 integrated manufacturers of building materials which account for over 80 percent of production.

Appalachian production is from two counties in Virginia. U.S. Gypsum Co. operates one mine in Smyth County, Subregion G, and another in Washington County, Subregion J. Virginia is one of the 10 additional States sharing 25 percent of the National output.

The major use of gypsum is in the manufacture of building materials principally as prefabricated products such as wallboard, lath, sheathing, and ceiling tile all of which consumed over 57 percent of the output in 1965. Loose applications of calcined gypsum in the building industry in 1965 used almost 12 percent. Uncalcined gypsum used as a retarder in portland cement consumed 3.2 million tons or 20 percent of the output in 1965. Agricultural uses, also uncalcined, were about 9 percent of the 1965 production. A small amount of calcined gypsum is used for industrial purposes such as in the manufacture of plate glass, terra cotta, pottery, models, and patterns. Calcined gypsum also is used as a filler, retarder, and desiccant, and for dental casts.

Gypsum deposits of good quality occur in many States. Measured resources in the United States have been estimated to be sufficient to provide 2,000 years of output at the present rates. Appalachia is deficient in known commercial gypsum deposits and obtains most of its gypsum from outside. At the projected rate of production, U.S. Gypsum Co. expects to operate its Virginia mines over 200 years.

Lime and hydraulic cement plasters compete with gypsum in the plaster field. Wood, plastics, organic fibers, aluminum, and glass (interior walls) compete with prefabricated gypsum products, but gypsum has an advantage over many competing products in that it is fire resistant and fire retardant.

Because Appalachian production facilities are units of the leading manufacturer in the industry, the Appalachian industry forecast is favorable.

Lime

Lime, or more properly burnt lime or quicklime, is prepared by the calcination or burning of either calcitic (high calcium) or dolomitic (high magnesium) limestones. In either case the production sites for lime manufacture usually coincide with deposits of high purity limestone or dolomite that are economically accessible. Lime is marketed in three forms - as calcitic or dolomitic quicklime, hydrated lime (calcitic or dolomitic), and deadburned dolomite. The latter form is used mainly as a refractory by the iron and steel industry and presently the only production in Appalachia comes from the eastern panhandle of West Virginia.

Production is by small merchant operators and by large multi-interest corporations which produce lime for captive use and also for

the open market. Lime, mainly high calcium, is produced in five of the 10 Subregions in Appalachia.

The lime-producing areas, in order of output in 1965, were as follows: Subregion B (13 operations in 10 counties, with virtually all production from Centre County, Pa.; and Jefferson, Berkeley, and Pendleton Counties, W. Va.); Subregion G (Giles and Smyth Counties, Va.); Subregion E (Shelby County, Ala.); Subregion F (Armstrong, Butler, and Westmoreland Counties, Pa.); and Subregion J (Knox County, Tenn.).

Although lime production in Appalachia in 1965 accounted for only 1.2 percent of the Region's total mineral value of $2,713 million (1958 constant dollars), it represented about 15 percent of the National output and value of lime. During the period 1961-65, lime output increased 31 percent and the value 36 percent (table 1 - 21). The gains were due principally to the ever-increasing demand for industrial lime in chemical and metallurgical applications.

Most of the lime produced in Appalachia is used in chemical and manufacturing processes; other uses include refractory, construction, and agricultural. Most of the regional output is internally consumed. The ever-increasing demand for high-purity lime by the chemical and metallurgical plants in Appalachia, especially by the iron and steel plants near Birmingham, Ala. (Subregion E), and Pittsburgh, Pa. (Subregion F), and the chemical and metallurgical industry along the Ohio River and its tributaries (Subregion G), far exceeds local production. Consequently, some high-purity lime is shipped into Appalachia for industrial use. Lime is an almost indispensable multifunctional mineral product and its many uses are shown in figure 1 - 10.

Resources of limestone are virtually inexhaustible in Appalachia. However, the stone occurs in many degrees of purity and only the high-grade carbonate rocks are suitable for the manufacture of high-purity lime. These pure limestones and dolomites are not as well distributed or plentiful as the lower grades. However, the reserves are probably adequate for future demands, although when easily accessible high-grade beds are depleted, production costs will rise as more expensive production methods are used, such as underground mining, and as it becomes necessary to utilize less accessible limestone deposits.

Although no large-scale increase is anticipated in the production of lime for its many and diverse uses, the growth outlook is favorable. Any decrease in use due to technological changes in industrial or chemical processes, or to substitution by other materials, may be more than offset by the rapidly increasing use of the basic oxygen process for steel manufacture, nationally and in Appalachia, with parallel increase in lime demand for this application. Other major growth areas in Appalachia will be in the fields of soil stabilization and stream pollution control, especially in combating acid water mine drainage.

TABLE 1 - 21. - Lime production and value in the Appalachian Region, 1961-65

Subregion	1961	1962	1963	1964	1965
	Production (thousand short tons)				
B	667	655	721	943	1,051
E	W	W	W	W	W
F	W	W	W	W	W
G	531	475	479	579	635
J	W	W	W	W	W
Undistributed	712	652	734	751	824
Total	1,910	1,782	1,934	2,273	2,510
	Value in thousand 1958 constant dollars				
B	$8,984	$8,697	$9,500	$12,056	$13,688
E	W	W	W	W	W
F	W	W	W	W	W
G	5,418	5,487	5,631	6,710	7,449
J	W	W	W	W	W
Undistributed	9,043	8,467	8,958	9,513	10,751
Total	23,445	22,651	24,089	28,279	31,888
	Distribution of production (percent)				
B	35	37	37	42	42
E	W	W	W	W	W
F	W	W	W	W	W
G	28	27	25	25	25
J	W	W	W	W	W
Undistributed	37	36	38	33	33
Total	100	100	100	100	100
	Distribution of value (percent)				
B	38	38	40	43	43
E	W	W	W	W	W
F	W	W	W	W	W
G	23	24	23	24	23
J	W	W	W	W	W
Undistributed	39	38	37	33	34
Total	100	100	100	100	100

W Withheld to avoid disclosing individual company confidential data; included with "Undistributed".

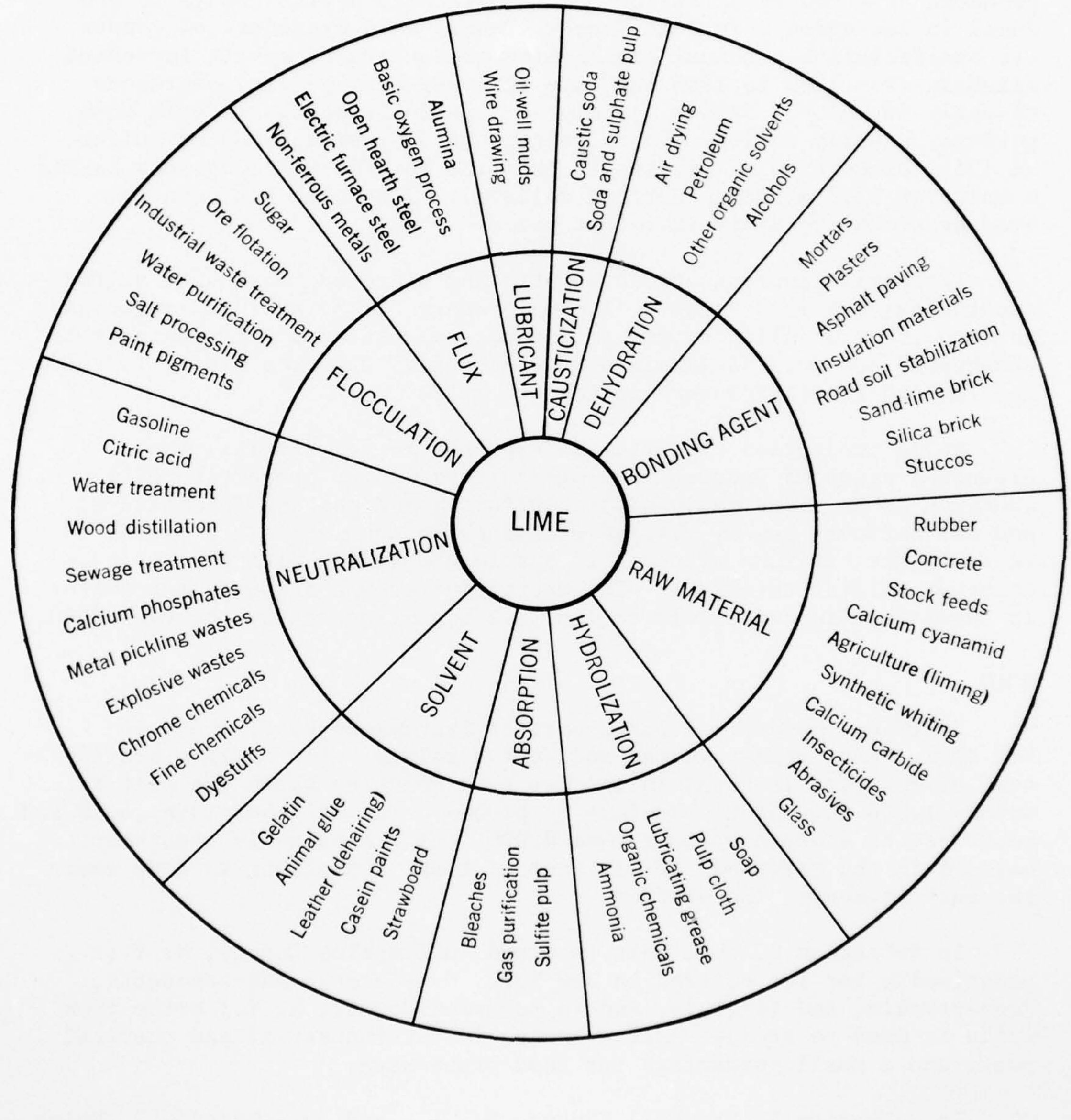

FIGURE 1 - 10. - Major Uses of Lime.

Pyrites (Sulfur)

Pyrites include a number of metal sulfides usually pyrite (FeS_2), marcasite (FeS_2), and pyrrhotite ($Fe_{1-x}S$). Normally, pyrites are produced as a source of sulfur. In Appalachia, pyrite (FeS_2) is produced in Subregion J in Polk County, Tenn., as a byproduct of copper ore beneficiation. Annual Appalachian production of pyrite increased slightly from 1961 to 1965 but, due to lower unit prices, decreased slightly in value. Sulfur, mainly as a sulfuric acid, produced from pyrites annually is less than 5 percent of U.S. production of sulfur. In 1965, production of pyrites in the U.S. was 874,957 long tons having a value of $5.3 million (current dollars). Tennessee has been the leading producing State in recent years.

The pyrite concentrate is roasted and sintered to produce sulfur dioxide gas and iron sinter. The major part of the sulfur dioxide gas is converted to sulfuric acid for industrial use, and the remainder is compressed and sold as liquid sulfur dioxide. The iron sinter is sold to iron and steel producers in Eastern States.

World production of sulfur is expected to grow to fill the expanding needs of industry and agriculture. U.S. production will continue to be principally native sulfur from domes and from natural and oil refinery gases. Pyrite resources in Appalachia are estimated to be in the billions of tons, if pyrite associated with coal is added to other sulfide resources. The use of pyrites as a source for sulfur in Appalachia is not likely to increase significantly by the year 2000.

Salt

Salt beds underlie a large part of Subregions B, F, and G in New York, Ohio, Pennsylvania, and West Virginia. The maximum bed thickness of 900 feet is found in the New York counties where the salt is within 1,000 feet of the surface in places. The salt beds dip south and southwest to a depth of more than 8,000 feet. Appalachia resources measure in the thousands of billions of tons, but mining is done where the salt is nearer the surface.

In Subregion B, rock salt is mined in Tompkins County, N. Y., principally for ice control in New York, New Jersey, Massachusetts, Pennsylvania, and Virginia, and in Schuyler County, N. Y.; brine from wells is used to produce salt principally for industrial and chemical uses, and a small percentage for food processing.

In Subregion F, Marshall County, W. Va., and in Subregion G, Meigs County, Ohio; Smyth County, Va.; and Kanawha and Pleasants Counties, W. Va., salt is recovered by solution mining or from connate brine. The brine is used for the manufacture of chlorine, caustic soda, soda ash, and other chemicals.

Salt produced in 1965 in these three subregions totaled approximately 3 million tons, valued at $21 million (current dollars). The salt produced in Subregions B, F, and G accounted for all Appalachian production and amounted to 8 percent of the National quantity and 10 percent of the National value.

In 1965, the chemical industry consumed 66 percent of the total U.S. salt output. Thirteen percent was used for ice control and roadbed stabilization. Food processing, agricultural feed, and all other uses accounted for the remainder. The outlook for increased salt production in Appalachia is largely dependent on whether or not new chemical plants are located in the Region.

The following discussion concerns those nonmetallic commodities whose contribution to the overall economy of Appalachia is slight, but have more or less local significance in terms of producing mineral-related employment and income.

Minor "Other" Nonmetals 3/

Abrasives

Natural abrasive materials are produced in Appalachia, but most of the markets have been taken over by the electric furnace products, fused alumina, and silicon carbide. One operator in Washington County, Ohio, Subregion G, produced grindstones. Tripoli, or rottenstone, for abrasive and filler uses was produced by two companies in Lycoming County, Pa., Subregion B, and one company in Lauderdale County, Ala., Subregion J. In 1965 National production of quartz sand screened to size, ground sand, and crushed and screened sandstone for abrasive uses amounted to 2.3 million tons valued at $8.2 million (current dollars). Appalachian areas shared in this business but separate data are not available.

Corundum, emery, and garnet deposits in Appalachia are not being exploited.

Asbestos

Asbestos is a name applied to a group of naturally fibrous minerals. The principal commercial variety is chrysotile; other commercial varieties are amosite, crocidolite, tremolite, and anthophyllite. Asbestos milling is a complex operation requiring minimum fiber damage to get the optimum yield from the natural grades. In Appalachia, one operator in Yancey County, N. C., Subregion J, produced amphibole asbestos from 1963 to 1965; output was less than 1 percent of U.S. production. The outlook for expanding the industry in Appalachia is not favorable because the ore bodies are small, and the amphibole asbestos has limited usage due to its inferior properties.

3/ Quantities and values for individual counties are withheld to avoid disclosing individual company confidential data.

Asphalt

One operator in Colbert County, Ala., Subregion J, produced native asphaltic limestone, which was crushed and marketed locally for surfacing roads. Beds of asphaltic sandstone and limestone are extensive in northwestern Alabama.

Bromine

Bromine was last produced in Kanawha County, W. Va., Subregion G, in 1961. Producers in other areas have ample resources such as brine wells, sea water, and saline-like brines so that Appalachian resources are of little importance.

Calcium-Magnesium Salts

One operator in Kanawha County, W. Va., Subregion G, recovers byproduct calcium-magnesium chloride from a brine salt process. Production and value are minor.

Gem Stones

Gem stone mining in the United States consists essentially of the activities of thousands of amateur collectors and hobbyists. There are more than 60 gem-minerals, mostly semiprecious, and at least one variety occurs in every State. Attempts to produce gem stones commercially have been few and intermittent. Most gem stones and mineral specimens are collected on a parttime basis or by amateurs.

Graphite

Historically, graphite was produced in Appalachia, but none has been produced in recent years. Graphite mining is insignificant in the United States and the only domestic production is from Texas. Imports satisfy practically all requirements for natural graphite. Manufactured graphite is produced from petroleum coke by baking at 950°C and subsequently graphitizing at about 2,800°C. Natural graphite deposits in Appalachia are not economically attractive under present conditions of world production and availability of graphite.

Iron Ore Pigment

Crude brown and yellow iron oxide pigments were produced from a mine in Pulaski County, Va., Subregion G. Pigment materials were also produced in Pennsylvania--Cambria County, Subregion B, in the form of sulfur mud and in Allegheny County, Subregion F, as a byproduct of alumina processing of bauxite. Crude and finished yellow iron oxide pigments were produced in Bartow County, Ga., Subregion E. Synthetic pigments have rendered the natural pigment industry nearly obsolete.

Mica

Mica is a group name for a number of complex hydrous potassium aluminum silicate minerals differing in chemical composition and physical properties but characterized by excellent basal cleavage that facilitates splitting into thin, tough, flexible, elastic sheets. Separate divisions of the mica industry produce sheet mica, the more valuable type, and scrap mica, which, because of size, color, or quality, is below specifications for sheet mica.

In 1965, North Carolina reported 714,000 pounds of sheet mica produced at a value of $185,000 (current dollars), and 72,000 tons of scrap mica at a value of $1,987,000 (current dollars). North Carolina produced 99 percent of U.S. sheet mica and 60 percent of U.S. scrap mica. Mitchell, Avery, Mason, and Yancey Counties, N. C., all in Subregion J, accounted for 60 percent of North Carolina's value of mica in 1965. In Subregion E, Cherokee and Jasper Counties, Ga., produced substantial quantities of scrap mica. Randolph County, Ala., Subregion E, reported a minor quantity of scrap mica.

Sheet mica is an important dielectric and insulating material in the electronic and electrical industries. Scrap mica is ground for use in numerous products but some scrap is reconstituted to sheets. Synthetic mica is manufactured by a fusion process in an arc-type electric furnace and is generally ground for the manufacture of glass-bonded materials.

The United States is not self-sufficient in any category of sheet mica or in high-quality scrap mica. India furnishes more than 80 percent of the sheet mica used in the United States. The Malagasy Republic and Brazil supply the rest of the market. The large amount of skilled hand labor required to process quality sheet mica from crude block makes preparation uneconomical in the United States. Ground mica production has been increasing and is likely to continue. This would provide a market for future production of scrap mica from pegmatites or schist.

Magnesium Compounds

Dolomite, sea water, and well brines provide the United States with abundant sources of magnesium and magnesium compounds. Dolomite, $Ca,Mg(CO_3)$, contains up to 22 percent magnesia (MgO). Dead-burned dolomite is obtained by heating the raw stone with iron additives at 3,000°F for a sufficient length of time to drive off volatile chemically combined constituents. Dead-burned dolomite is chemically inactive and is used primarily as a refractory for lining open hearth steel furnaces. Dolomite of the required purity is not widely distributed in Appalachia. Presently, the only production of dead-burned dolomite comes from the eastern panhandle of West Virginia, although production was reported in Jefferson County, Ala., in 1962. While dolomite is a potential source of magnesium and its compounds, most magnesium is produced from sea water and natural brines.

Olivine

Olivine is a magnesium silicate mineral whose principal use is as a foundry sand; it has a minor use as a refractory and a source of magnesium. Operators in Jackson and Yancey Counties, N. C., Subregion J, reported production from 1961 to 1965. The output has increased an average of 7 percent per year in quantity and 23 percent in value. In 1965, North Carolina ranked second nationally in the production of olivine with 32 percent of the output. Reserves of olivine in North Carolina and Georgia are estimated at 230 million tons. Olivine is less desirable than high-purity magnesia for high temperature refractories and as a result, its use will be increasingly restricted to use as foundry sand.

Potassium Salts

Potassium sulfate is recovered as a byproduct of cement manufacture in Washington County, Md., Subregion B. The product is sold for agricultural uses. The output and value are negligible compared to other areas nationally.

Peat

Although used for fuel in other countries, peat cannot compete in U.S. fuel markets. Peat is produced in the United States for use in agriculture and horticulture, principally as an amendment for soil improvement. In the period 1961-65, Appalachian peat production was from seven counties in Pennsylvania: Lackawanna, Luzerne, Monroe, and Wayne in Subregion A; Columbia in Subregion B; and Erie and Lawrence in Subregion F. In 1965, Pennsylvania peat production was by 12 operators and amounted to 57,400 tons of which 45,600 tons was sold at a value of $527,000 (current dollars). Nationally, sales of domestic peat were 604,000 tons valued at $6 million (current dollars). Peat imports in 1965 were 275,000 tons valued at $12 million (current dollars). Appalachia's share of the total market was 5.2 percent of the volume and 2.9 percent of the value. Peat reserves in Pennsylvania were estimated in 1953 at 1 million tons but recent surveys indicate greater reserves. The outlook is expected to be for continued modest growth.

Talc

Talc, a hydrous magnesium silicate, is a soft, white to green-gray mineral. Present usage limits the name, steatite, to grades of talc suitable for making electron tube spacers and insulators. Soapstone includes all the less pure, massive gray to blue or green talcose rocks which feel soapy and can be carved easily with a knife. Pyrophyllite, a hydrous aluminum silicate, is similar to talc in its properties and in most of its applications. Sericite, a type of mica, can be substituted for talc, soapstone, and pyrophyllite for some purposes.

Domestic production of talc, soapstone, and pyrophyllite in 1965 was 863,000 short tons valued at $6.3 million (current dollars).

Appalachian production in 1965 was reported from Murray County, Ga., and Talledega County, Ala., in Subregion E, and Cherokee County, N. C., in Subregion J. Sericite schist has been produced in Cherokee County, Ga., Subregion E, but no production was reported in 1965. Production and value from the Appalachian Subregions amounted to less than 10 percent of the National output.

Talc, soapstone, and pyrophyllite are used chiefly as finely ground material in the ceramic, paint, rubber, insecticide, roofing, and paper industries. Sawed and shaped slabs of soapstone are used for sinks, electrical base plates, and bench tops. Crayons and carvings are made from lump talc.

Nationally in 1965, ceramics used 32 percent of the talc shipped by producers; paint, 18 percent; insecticides, 8 percent; roofing, 7 percent; paper, 6 percent; rubber, 3 percent; toilet preparations, 3 percent; and other filler applications, 23 percent.

Except for block steatite talc, the United States has ample reserves of talc, soapstone, and pyrophyllite. Bonded block material may be used as a replacement for natural steatite and is equal in performance but more expensive. Other minerals such as clays, feldspars, kyanite, mica, quartz, and wollastonite are competitive with the talcose minerals. The outlook for the talcose minerals is for continued growth in line with recent history.

Vermiculite

Vermiculite is the name of a specific mineral and also the commercial term applied to a group of micaceous minerals that expand greatly, up to 20 times its original bulk on rapid heating.

Appalachian production was reported from Spartanburg County, S.C., Subregion D, in 1961 and 1962. Since then all eastern U.S. production has come from Laurens County, S.C., outside the Appalachian Region, but adjacent to Spartanburg County.

Uses are principally in construction as plaster and concrete aggregate, loose fill insulation, and horticulture. Vermiculite encounters competition from long-established commodities in all its fields of use.

METALS

Iron Ore

Although iron-bearing formations are distributed widely in the Appalachian Region, ore deposits are generally low grade or relatively small and production has been declining for several years.

A century and more ago, these deposits provided the iron ore for the numerous iron and steelmaking enterprises which were established in the Region. In the last decade of the 19th century, iron ore from northern Appalachian sources was displaced by Lake Superior ores, and northern Appalachian output in the 20th century has been negligible. Since 1951, the red iron ores of southern Appalachia have been gradually displaced in their marketing area by high-grade foreign ores.

Some red iron ores, and brown ore from relatively small deposits, widely dispersed throughout the States in Appalachia, continue to be mined. Small tonnages of iron ore also are produced for the manufacture of pigments.

For many years nearly all the iron ore produced in the Region has been mined from southern Appalachian deposits of hematite (red ore) and limonite (brown ore) for iron and steel making. These ores, plus a relatively small output of byproduct iron oxide sinter from nonferrous smelting in Polk County, Tenn., are consumed by iron and steel plants in the Region at Gadsden and in the Birmingham district, Alabama. Nearly all the ore is consumed in blast furnace smelting, but a small proportion (less than 5 percent) is used in steelmaking.

Red and brown ores of the southern Appalachian Region both suffer from disadvantages of being low grade and undesirably high in phosphorus content. Beneficiation methods, including flotation, are available for upgrading brown ores, but the red ores are difficult to beneficiate without costly roasting and magnetic separation. The high phosphorus content of these ores limits their use in modern ironmaking; generally they are blended with low-phosphorus foreign ores. Perhaps the most critical factor is the low grade and the great dispersion of the deposits; average individual mine output of usable ore in 1965 was only 62,000 tons. In the Russellville, Ala., district, there is a massive brown ore deposit large enough to support a concentration plant, but the market for this ore is limited by the high-phosphorus content. There are other extensive deposits but they are of low iron content and not of current economic interest to producers.

The present outlook for iron ore mining in the southern Appalachian Region is that of continuing decline. Appalachian ores are so much costlier to smelt that they are sold at prices per unit of contained iron that are as low as one-third the price of the highest grade imported materials. The producers are confronted with increasing operating costs, and a relatively stable price for higher grade imported ore. Thus, the

producers cannot pass their increasing costs on to the buyer. Moreover, intensive development of foreign ore sources over the past two decades has provided abundant reserves of high-grade ores for many years ahead.

The pattern of ore consumption in the Alabama iron and steel plants since 1960 further reveals the situation. Imported ore accounted for 32 percent of the ore consumed in 1961, 50 percent in 1963, and 65 percent in 1965. In the same time span, production and value (1958 constant dollars) of Appalachian ores declined from 8,739,000 long tons valued at $39.6 million in 1951 to 3,140,000 long tons valued at $18.1 million in 1961 and then to 1,028,000 long tons valued at $5.9 million in 1965.

If present trends continue, virtual cessation of southern Appalachian iron ore production is foreseen by 1970 or soon thereafter.

Zinc and Lead

Geographic Distribution and Structure of the Industry

Mining of lead dates back to the Revolutionary War, but in recent years virtually all the lead produced in the Region has been recovered as a coproduct from zinc-lead operations in Wythe County, Va. Mining for zinc reportedly started about 1816 but production was not significant until the latter part of the century. Deposits of zinc are widely distributed in the southern part of the Appalachian Region; zinc districts are shown in figure 1 - 11.

Sphalerite (ZnS) and galena (PbS) are the principal zinc and lead minerals in the Appalachian Region. They occur together, but in most deposits sphalerite is by far the most abundant. In the Blue Ridge and Piedmont provinces the minerals occur as vein, disseminated, or massive replacement deposits; the most important are the massive copper-bearing sulfide bodies of the Ducktown district in Polk County, Tenn. In the Valley and Ridge province most zinc and lead sulfide ores are found in limestones and dolomites as open-space filling and replacement bodies, particularly in breccias. These include the Austinville (Wythe County, Va.) and Embreeville (Unicoi and Washington Counties, Tenn.) districts, also the Mascot-Jefferson City district (Jefferson, Hancock, and Knox Counties, Tenn.), one of the principal zinc-producing districts in the United States. In the Appalachian Plateaus and Interior Low Plateaus occurrences of lesser magnitude have been recorded, particularly in central Tennessee and in central and south-central Kentucky. Occurrences of zinc and lead sulfides have been reported within each State in the Region with the exception of New York (even here, deposits are found just east of Appalachia).

In 1965, mining for zinc minerals was carried on by five companies at 16 mines in five counties in the Region. First in importance was the Mascot-Jefferson City, Tenn., district, where zinc ores were mined.

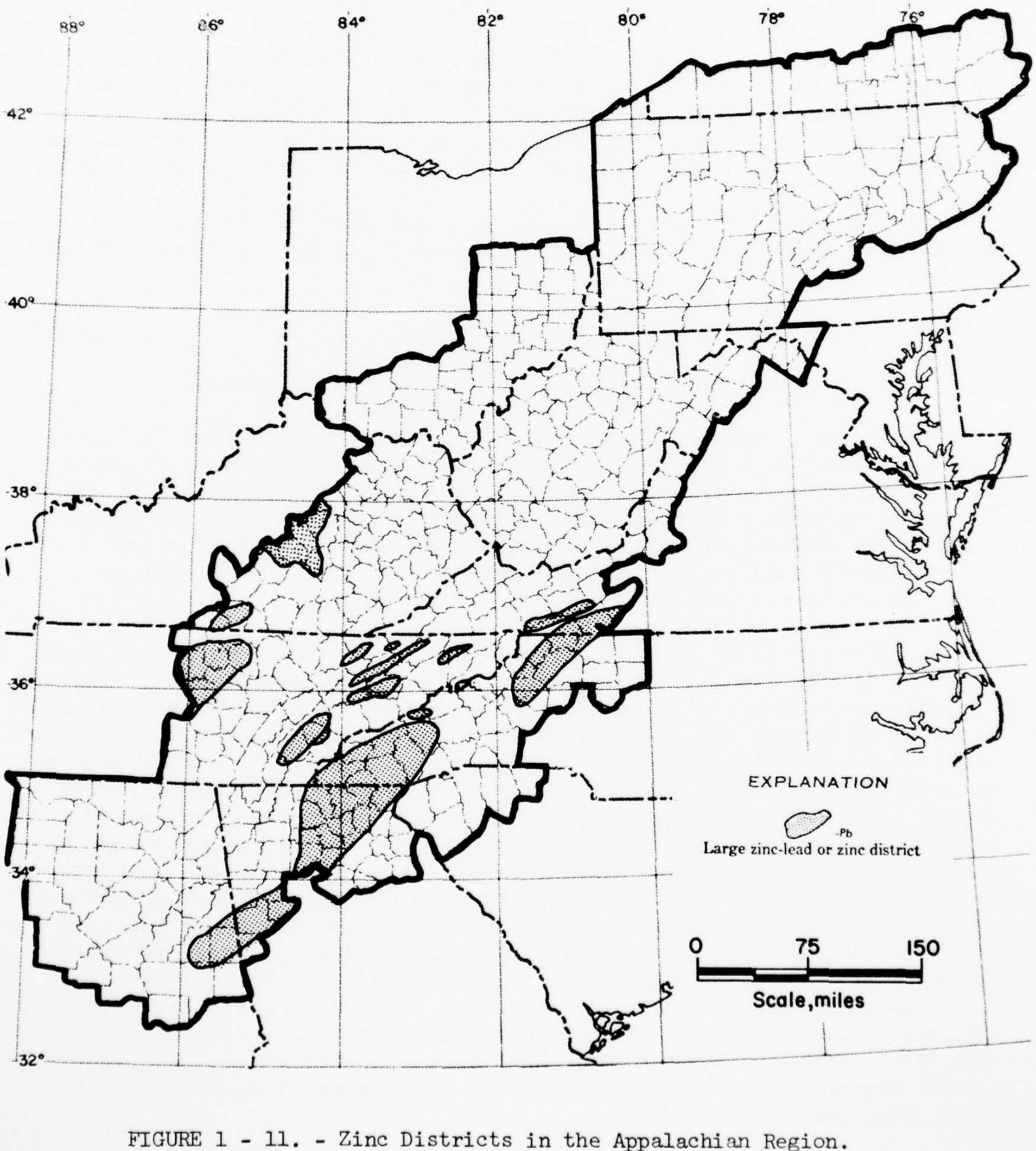

FIGURE 1 - 11. - Zinc Districts in the Appalachian Region. (Adapted from Fig. 115, U.S. Geological Survey, Professional Paper 580, 1968)

Next in rank was the Ducktown, Tenn., district, where copper-zinc ores were mined. Lastly, the Austinville, Va., district, where zinc-lead ores were mined. The ores are concentrated at mills which serve one or more mines within a district. The chief markets for lead and zinc concentrates are smelters outside the Appalachian Region. Only two zinc smelters are located in the Region. The zinc smelter at Meadowbrook, W. Va., treats chiefly foreign ores. The zinc smelter at Josephtown, Pa., treats zinc concentrates from Tennessee mines, but the chief source of supply of zinc concentrates for the smelter is from mines outside the Appalachian Region.

In the Austinville, Va., district, total metal value in terms of recoverable zinc and lead was distributed 84 percent zinc and 16 percent lead. In the combined Tennessee districts the comparable distribution was 77.1 percent zinc, 22.6 percent copper, 0.3 percent silver, and about 0.01 percent gold. All of the copper, silver, and gold production originated in the mines of the Ducktown district. The Mascot-Jefferson City district produced only zinc ore.

Current Regional Production and Relationship to National Production

Production data in this report for zinc and associated metals refer to the mine production of recoverable metals, that is, the total content of each metal in the ore mined has been adjusted to reflect the loss of metal in concentration, smelting, and refining.

Zinc production within the Region in 1965 totaled 143,000 tons valued at $30.6 million (1958 constant dollars) (table 1 - 22). During the 1961-65 study period the Appalachian zinc mining industry accelerated the growth that began in the early 1950's (1962 production reflected the production loss caused by a mine flooding accident). Production in 1965 was 37 percent greater than in 1961, an average growth of 8.2 percent. Growth has resulted almost entirely from expansion of mining in the Mascot-Jefferson City, Tenn., district, where the zinc ore is essentially free of lead.

The Ducktown, Tenn., district has experienced much less growth as witnessed by the relatively slight growth in production of the associated metals--copper, silver, and gold (table 1 - 23). The Austinville, Va., district has regressed; zinc production declined about 10 percent in the period 1961-65.

Zinc mining in Appalachia is growing faster than the domestic zinc mining industry as a whole. In the early 1950's Appalachian zinc claimed about 7 percent of the National production; by 1953 it had risen to over 10 percent for the first time. Growth in the domestic industry has continued, and in 1959 Appalachian zinc supplied more than 20 percent of the Nation's production. From 1961 to 1965 the proportion rose further from 22 percent in 1961 to about 24 percent in 1965.

TABLE 1 - 22. - Zinc (recoverable content of ores, etc.) production and value in the Appalachian Region, 1961-65

Subregion	1961	1962	1963	1964	1965
	Production (short tons)				
G	22,586	20,214	20,864	21,004	20,491
J	81,734	71,548	95,847	115,943	122,387
Total	104,320	91,762	116,711	136,947	142,878
	Value in thousand 1958 constant dollars				
G	$4,610	$4,119	$4,349	$4,567	$4,366
J	16,622	14,422	19,153	25,269	26,258
Total	21,232	18,541	23,502	29,836	30,624
	Distribution of production (percent)				
G	22	22	18	15	14
J	78	78	82	85	86
Total	100	100	100	100	100
	Distribution of value (percent)				
G	22	22	19	15	14
J	78	78	81	85	86
Total	100	100	100	100	100

TABLE 1 - 23. - Mine production of recoverable lead, copper, silver, and gold in the Appalachian Region, 1961-65

Mineral	1961	1962	1963	1964	1965
Production:					
Lead............short tons..........	3,733	4,059	3,500	3,857	3,651
Copper.............do..............	1/18,200	1/17,900	13,717	13,889	14,823
Silver..........troy oz............	83,417	112,251	107,913	90,539	94,142
Gold...............do..............	152	158	137	133	122
Value, thousand 1958 constant dollars:					
Lead...............................	680	655	657	810	837
Copper.............................	1/9,655	1/9,667	7,341	7,256	7,711
Silver.............................	76	113	119	100	105
Gold...............................	5	6	4	4	3

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MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

Lead production in Appalachia stands in marked contrast to zinc. During the 1961-65 period, lead production, entirely in the Austinville, Va., district in Subregion G, held steady at about 3,700 tons. In the same time span lead production in the United States rose 15 percent to 301,000 tons in 1965. The result was a decline in the Appalachian share of domestic production from 1.4 percent in 1961 to 1.2 percent in 1965.

Major Uses and Economic Importance of the Industry

Domestic consumption of zinc from all sources increased 44 percent in the 1961-65 period to 1.7 million tons in 1965, almost entirely from growth in the die casting and galvanizing industries. In 1965, these two markets consumed 72 percent of the total, 38 percent for zinc-base die casting alloys and 34 percent for galvanizing. Brass and bronze markets took 16 percent, mostly supplied from scrap zinc. The remaining 12 percent was accounted for by zinc oxide, rolled zinc, zinc dust, light-metal alloys, chemical products, and other uses.

New zinc supplied 80 percent of the domestic requirements in 1965; the remaining 20 percent came from secondary zinc recovery. These proportions are typical of the past 10 years.

Imported zinc also is a factor in the domestic zinc market. In 1965, this source supplied 557,000 tons of zinc in concentrates or as metal for consumption, 52 percent from Canada, 21 percent from Mexico, and 13 percent from Peru. Imports had declined during the preceding decade, but the lifting of import quotas in 1965 was followed by a rise in import volume. Imports for consumption and secondary zinc in 1965 accounted for 32 percent and 20 percent of the zinc supply respectively, and totaled 52 percent of domestic zinc consumption.

Although an important source of zinc ores and concentrates, Appalachia has only two primary zinc smelters. Much of the zinc concentrate produced in Appalachia is smelted, refined, and converted outside the Region. Thus, the potential exists for growth in zinc smelting and refining and zinc-based manufacturing activity in the Region.

The paucity of zinc processing capacity in the Region has the further effect of imposing transportation charges for backhauling if zinc is to be used for manufacturing in the Region. This chain of circumstances is particularly unfortunate because zinc is so widely used in consumer product categories that are growing rapidly. Zinc-base alloy die castings have strong market acceptance--they are much used for mass-produced, complex-shaped machinery parts, and also highly-styled decorative components intended for bright plating. Galvanized sheet steel is the fastest-growing segment of the steel market.

In 1965, lead was consumed in the United States for storage batteries, 37 percent; other metal and metal products, 33 percent; antiknock compounds for gasoline, 18 percent; pigments, 9 percent; and other uses, 3 percent. In 1965, the consumption of lead in the United States totaled 1.24 million tons, 47 percent from domestic scrap, 28 percent was imported, and 25 percent originated in domestic ores. The average price of lead in 1965 was 16.0 cents per pound, making lead a near $4 billion market in the United States. The Appalachian output of lead (table 1 - 23) accounted for only 0.3 percent of domestic consumption and is a minor factor in the lead industry.

Resource Potential

In recent years the Mascot-Jefferson City district has come to the fore, making Tennessee the leading zinc-producing State in the Nation; it has the potential to maintain this position for some decades. During the past 15 years the output of zinc in this district has grown more than three times as fast as the growth in total domestic production.

Reserves of zinc ores in the Appalachian Region stand at an all-time high and the search for additional reserves continues. The major producing companies of the Region are exploring for extensions to their existing mines. They and other mining companies also are studying the potential of the Region for new mining districts and are applying modern geochemical prospecting methods to reevaluate districts which formerly were productive.

In 1965, the reserves of one important producer were sufficient for about 40 years at the 1965 rate of production. Another producer only extends his exploration to maintain a 15-year reserve on his properties. A Bureau of Mines study in 1964 identified reserves and prospects exceeding 10 million tons of zinc in the Appalachian Region, over 80 years of production at the 1965 rate.

Problems and Outlook

Zinc producers in Appalachia are confronted by three problems, two operational, the other in marketing. Exploration and mining costs are rising. Established mines may have to cope with lower grade ores as present workings become depleted. Domestic production will be increasingly subjected to marketing competition from imports, both from ore and refined metal, because domestic production is mainly from lower grade ores, hence, mining costs are higher in relation to metal content.

The outlook for zinc mining in Appalachia is basically optimistic simply because consumption of zinc in the United States is growing. Bureau of Mines projections in 1965 indicated that United States production of zinc would grow at the rate of 3.1 percent to 1975, somewhat

less than the rise in gross national product. However, that projection implicitly reflected the effects of the import quota imposed in 1958. Since late 1965 when that quota was removed, imports have risen (particularly from Canada, the world's largest zinc producer). The pressure of imported zinc is felt particularly by domestic producers east of the Mississippi River and notably within the Appalachian Region. In the absence of import quotas one producer foresees no gain in Appalachian zinc production to 1980, another looks forward to a decline followed by a rise in the 1970's to the 1965 level by 1980. Old mines will be phased out, but the development of new mines may be held back.

Projections for Appalachian zinc production are hampered not only by the role of imported zinc in the market, but also by a realization that the spurt of growth enjoyed by Tennessee producers in the 1955-65 period probably cannot be maintained. Appalachian mines are likely to continue to claim a larger share of domestic zinc production, rising to about 28 percent by 1980 and 35 percent by 2000 because of the abundance of presently known reserves compared to reserves in the western States. If in this timespan the United States production of zinc grows at a 1.4 percent rate, production of zinc in the Appalachian Region may reach 210,000 tons by 1980 (a 2.6 percent rate of growth 1965-80), and 344,000 tons by 2000 (2.5 percent growth 1980-2000).

Appalachian lead production is too small a factor in the lead market to warrant projections. It seems likely, however, that not much growth is to be expected since lead production depends on zinc production in the Austinville, Va., district, where no growth has occurred in recent years.

Other Metals

Aluminum

Aluminum is produced by the electrolytic reduction of alumina (Al_2O_3) which is obtained by chemical processing of bauxite, a mixture of aluminum hydroxides with impurities of iron, titanium, and silica. Some bauxite is mined in Appalachia, but used for purposes other than making aluminum. Aluminum is produced in Appalachia in four plants with a total annual capacity of 672,000 short tons or 25 percent of the total United States capacity.

The only bauxite mined in Appalachia since World War II came from northwest Georgia; it was used chiefly for the production of chemicals.

Bauxite occurs in the Valley and Ridge province of Appalachia from west-central Virginia to northwestern Alabama and in the Margerum district of Alabama in the Interior Low Plateau province. Largest reserves are in residuum that accumulated in sinkholes or other depressions in Cambrian or Ordovician carbonate rocks of the Valley and Ridge province. Known deposits range from a few feet to about 200 feet

in diameter and extend to a depth of about 200 feet. Total measured, indicated, and inferred reserves including bauxitic clay were estimated, as of 1960, at 935,000 long tons in the Valley and Ridge province and 100,000 long tons in the Interior Low Plateau province.

Known deposits of bauxite in Appalachia are too small and scattered to be a major source of aluminum, but probably are adequate to sustain production for use in chemicals at somewhat greater than the present rate for several decades. The discovery of large bauxite deposits in Appalachia is unlikely.

Aluminous rocks other than bauxite include saprolite, shale, high-alumina clay, igneous rocks, and metamorphic rocks containing andalusite, kyanite, and sillimanite. Large-scale use of these materials as a source of aluminum is not likely in the near future.

Development of the aluminum industry is dependent upon low-cost electric power for production of metal from alumina. The 7 to 8 kilowatt-hours of electricity presently required to produce 1 pound of aluminum represents about 20 percent of the total production cost. Low cost power rates and transportation facilities, such as waterways, might enhance development of the aluminum industry in Appalachia.

Cadmium

Cadmium is produced only as a byproduct of the smelting of zinc sulfide concentrates. In 1964, the New Jersey Zinc Co. at Palmerton, Pa., and the St. Joseph Lead Co. at Josephtown, Pa., produced cadmium metal in Appalachia.

The geographic and geologic distribution of cadmium minerals is similar to that of zinc ore in which it occurs. As zinc output from Appalachia is expected to increase over the next few years, the quantity of cadmium produced as a byproduct also should increase.

Chromium

Chromite is the only ore of chromium. The largest chromite occurrences in Appalachia are in western North Carolina. Known deposits are lenses and pods in altered peridotite or alluvial sediments derived from bedrock deposits.

No chromite has been mined in the United States since 1961. The lack of significant production for Government purchase programs at two or three times world prices during World War II and the Korean War indicates that the outlook for an Appalachian chromite industry is poor.

Cobalt and Nickel

Cobalt and nickel, which commonly occur together in sulfides of iron and copper or in residual weathering products of mafic igneous rocks, never have been produced in Appalachia. All cobalt produced in the United States in 1964 was a byproduct of iron ore mined in Pennsylvania just outside the Region.

Most cobalt is used in alloys, paints, and ceramics; the largest use of nickel is in stainless steel and other alloys.

There are no economically attractive reserves of cobalt or nickel in Appalachia, but it may be feasible to recover byproduct cobalt from sulfide deposits of the Region in the future.

Columbium (Niobium) and Tantalum

The rare metals columbium (niobium) and tantalum are used in electronic, nuclear, chemical, and high-temperature applications. The metals commonly occur together. The United States relies almost entirely upon foreign ore. No domestic production has been marketed since 1959, except a small quantity of columbium and tantalum produced in 1966 as a byproduct of feldspar mining in South Dakota, and placed in stockpile. Columbium and tantalum were recovered from Idaho placers prior to 1959.

Pegmatites are the only known source of columbium and tantalum in Appalachia; the metals have been produced in small quantities, principally from the part of the Region in western North Carolina. Placers derived from pegmatites may contain columbium and tantalum. Deposits of these rare metals seem to be small and low-grade in Appalachia, and there is little promise for significant discoveries in the Region.

Copper

Copper and copper alloys are used in applications where high electrical and thermal conductivity, ductility, malleability, strength, or corrosion resistance is desired.

Recent production of copper in Appalachia has been confined to three localities: (1) The Ducktown district in Polk County, Tenn., where copper has been produced nearly continuously since 1850; (2) the Ore Knob Mine in Ashe County, N. C., where copper was produced from 1955 to 1962; and (3) the Fontana Mine in Swain County, N. C., which operated from 1926 until 1944 when it was isolated by the Fontana Reservoir. The copper industry is of regional economic importance in the vicinity of Polk County, Tenn., where copper is produced; and also

in Centre County, Pa., and Lawrence County, Ala., where copper metal and alloys are fabricated. Other potential reserves of copper ore occur in Appalachia. Massive and disseminated copper-bearing sulfide deposits are restricted to the Blue Ridge and Piedmont provinces from just north of the Virginia-North Carolina boundary southwestward into Alabama. The sulfide deposits are similar to those in the Ducktown district of Tennessee. Sulfide-bearing quartz veins are associated with some massive and disseminated sulfide bodies, and may contain copper minerals. Early Paleozoic sandstone and shale contains low-grade copper mineralization in the Appalachian Plateaus province of northeastern Pennsylvania.

There is excellent potential for the discovery of minable copper-bearing pyrite or pyrrhotite, particularly the massive sulfide type, in the Blue Ridge and Piedmont provinces of Appalachia.

Gold

The principal use of gold is to give stability to paper currencies and to settle international trade balances. The price of gold produced in the United States is fixed at $35 per fine troy ounce; consequently, rising costs of production and depletion of high-grade deposits have resulted in the closing of most domestic gold mines.

Most gold found in Appalachia has been in placers, and in meta-sedimentary and associated granitic rocks of the Piedmont province. During the last 25 years, nearly all gold recovered in the Region has been a byproduct of copper ore. About 140 ounces of gold valued at $5,000 was recovered in Appalachia in 1964.

There is potential for finding new deposits of gold, particularly in large low-grade deposits that might be exploited by modern large-scale mining methods.

Manganese

About 95 percent of the manganese consumed in the United States is used in steel production; and no competitive substitute has been found. Imported ores are used for essentially all domestic manganese consumption. Ferromanganese, an alloy containing about 75 percent manganese, 14 percent iron, and 11 percent other material, is produced in Appalachia for use by the steel industry. Production of ferromanganese is concentrated near steel centers and in the Tennessee Valley Authority (TVA) area where electric power is inexpensive.

Manganese ore deposits in Appalachia have been small and irregular. The ore commonly required upgrading to attain marketable grade. Appalachian manganese ore production has been virtually displaced by

competition from high-grade foreign imports since the end of World War II. Later production of ore in Appalachia has been insignificant, except during the 1952-59 period when the Government purchased manganese ore at above world prices.

Except for limited use of manganese carbonate, only oxide minerals are mined for manganese. During the last 50 years, oxides have been exploited in Appalachia. The most important ores have been residual clay derived from carbonate rocks, particularly the Shady and Tomstown Dolomites of Cambrian age. Of lesser importance, are oxide coatings and fracture fillings in quartzite and sandstone. Both types of ore occur in the Valley and Ridge province.

No measured reserves of minable manganese ore are known in Appalachia. It is likely that new deposits will be found, however, those discovered in the future probably will be small, irregular, and low in grade. The potential for manganese ore is best in residual clay derived from carbonates in Cambrian strata of the Valley and Ridge province.

Silver

The principal uses of silver are in coins and photographic, electrical, jewelry, and dental products. No ore is mined primarily for silver in Appalachia, but it has been produced in the Region as a byproduct in lead, zinc, copper, and gold ores.

Practically all silver produced in Appalachia has come from Tennessee and North Carolina. About 91,000 troy ounces of silver valued at about $117,000 was recovered as a byproduct of copper ore mined in the Ducktown district of Tennessee in 1964.

Lead-zinc deposits in dolomite and limestone in the Valley and Ridge province of Appalachia, and copper-bearing sulfides in metamorphosed rocks of the Blue Ridge and Piedmont provinces contain minute percentages of silver. The potential for Appalachian silver production is tied closely to future copper, lead, zinc, and gold production.

Thorium and Rare-Earth Metals

The rare-earth metals are lanthanum, cerium, praesodymium, neodymium, promethium, samarium, europium, gadolinium, terbium, dysprosium, holmium, erbium, thulium, ytterbium, and lutetium. These elements of the lanthanide series are commonly associated with thorium in nature. The minerals monazite and bastnaesite are the most important sources of thorium and the rare-earth metals. Other sources are the minerals xenotime, samarskite, fergusonite, and euxenite.

Thorium is used principally in the manufacture of chemical and medical products, refractories, polishing compounds, magnesium alloys, electronic products, and gas mantles. The rare-earth metals are used in polishing compounds, and in electronic, chemical, and metallurgical applications. The use of thorium for nuclear fuel is in the experimental stage, and it may some day supplement uranium.

Thorium and rare-earth metals have been mined in Appalachia, particularly in North Carolina, prior to about 1910. Pegmatites and other granitic rocks in the Piedmont and Blue Ridge provinces of southern Appalachia contain small quantities of thorium and rare-earth metal minerals. Higher concentrations of these metals occur in monazite placers in the Piedmont province.

Monazite placers in the Region range from large and low-grade to small and high-grade, and occur in belts of locally derived alluvium. The placers do not appear to be economically minable at present, but may become so, particularly if other minerals (i.e. gold, cassiterite, zircon, ilmenite, uranium minerals, and rutile) can be recovered concurrently.

Tin

Nearly all tin used in the United States is imported. Historically, the total United States production of tin, chiefly from Alaska, would barely meet one week's domestic requirements. The metal is used in protective coatings for metals, alloys, stabilizers for plastics, wood preservatives, fungicides, and insecticides.

Tin has been produced in Appalachia, principally from Alabama and the Carolinas, but there has been no production since 1942. Some byproduct tin was recovered from spodumene ore in North Carolina, just east of the Region, as late as 1953.

Tin resources in Appalachia consist of cassiterite in placers, pegmatites, quartz veins, and quartz-muscovite greisens; the host rock for most deposits is schist and gneiss of probable Precambrian age. Most of the known tin deposits in Appalachia are in the Piedmont province along the east flank of the Blue Ridge. It is not likely that any of the known lode deposits could be mined at a profit; and potential for the discovery of minable lode deposits is poor. Placers, however, can be mined at lower cost and elaborate milling facilities are not required to attain shipping grade. Therefore, some small placers which occur in the area probably are minable. Tin placers which also contain thorium, rare-earth metals, or other values are most likely to be exploited.

Titanium

Ilmenite and rutile are the most important minerals of titanium. Another source of titanium is titaniferous slag obtained by smelting a

mixture of carbon and titaniferous material (commonly titaniferous iron ore) in an electric furnace. Much of the slag used in the United States is imported from Canada.

Nearly all ilmenite and titanium slag is used to manufacture titanium dioxide for pigments used principally in paints and paper. Most rutile is used for making titanium metal and for welding rod coatings. Titanium metal and alloys are used where lightweight, high melting point, resistance to fatigue and corrosion, and toughness are required.

A considerable quantity of titanium minerals was produced in Appalachia, principally from Caldwell County, N. C., between 1942 and 1952. Titanium minerals also have been produced just outside Appalachia in North Carolina and in Virginia; ilmenite is produced currently near Piney River, Va.

Rutile and ilmenite occur in Appalachia in primary lode deposits, many of which are associated with titaniferous magnetite veins in schist and gneiss of probable Precambrian age. Other deposits of titanium minerals are in saprolites and placers; these secondary deposits derived from weathered lodes commonly are richer in titanium minerals than the primary deposits. Some titanium placers contain monazite, zircon, and other heavy minerals.

The geological relationships of primary titanium deposits in the Region are not well known, consequently, the potential for discovery of minable deposits is not known. However, the potential for discovery of small titanium placers appears to be good. Potential of saprolite deposits found in the weathered zone of primary (lode) deposits cannot be evaluated until the geological relationships of primary titanium deposits in Appalachia are learned. The future prospects for development of titanium deposits is dependent on demand, which is increasing, and on advances in technology of processing and refining.

Tungsten

The most important tungsten minerals are scheelite, other calcium tungstates, and iron-manganese tungstates such as wolframite and huebnerite. Tungsten is used principally in steel, other alloys, and carbides where extreme hardness, high melting point, and high density are required.

Although tungsten minerals have been reported from 10 localities in the Piedmont province of Appalachia, tungsten has not been produced in the Region. At the reported localities, tungsten occurred in low concentration in gold and copper lodes and placers. Tungsten deposits occur just outside Appalachia, however, in the Hamme district of Vance County, N. C.

Uranium

Although the United States has produced a large quantity of uranium during the last 15 years, only about 300 tons of the ore came from Carbon County, Pa., in Appalachia.

The Federal Government is the principal user of uranium, most of which is for nuclear weapons. Use of uranium as fuel for generating electric power is increasing. Research is being directed toward the feasibility of using uranium in nuclear explosions to fracture and move rock for purposes such as mining, petroleum and gas production, and construction. The trend in the uranium industry is toward less Government financing and control and more nonmilitary uses of uranium. At the present time there is no substitute for uranium as a nuclear fuel, although thorium may complement uranium in the future.

The most promising uranium deposits known in Appalachia are in continental sandstone and mudstone. Nearly all reported deposits of this type are in Pennsylvania, and the majority are in the lower part of the Catskill Formation of Late Devonian and Early Mississippian age. Similar deposits occur in the Pocono and Mauch Chunk (Mississippian age) and Pottsville (Pennsylvanian age) Formations. Copper mineralization is associated with some of the uranium deposits in Pennsylvania.

Uranium-bearing veins also occur in Appalachia; they have been reported in crystalline metamorphic rocks of Precambrian age in North Carolina and Tennessee. Although uranium-bearing pegmatites are not common in Appalachia, they occur in the Spruce Pine district of Mitchell and Yancey Counties, N. C. Possibilities for commercial production from veins or pegmatites is poor.

Monazite placers in the Carolinas contain uranium, but none are known to be of sufficient grade and tonnage to be mined.

The Chattanooga Shale of Late Devonian and Early Mississippian age contains large low-grade uranium resources in Tennessee, Kentucky, and Alabama, but none is expected to be recovered in the near future.

Known resources of uranium in Appalachia probably contain no more than a few thousand tons of ore. Most of this ore is in continental sandstone and mudstone deposits of Carbon County, Pa. Similar deposits may contain appreciable uranium resources. Monazite placers in the Carolinas could yield uranium minerals if mining were done for thorium and rare-earth metals.

Vanadium

The principal use of vanadium is in alloys of iron, aluminum, and titanium. The addition of vanadium to an alloy controls grain size

and thermal expansion, imparts toughness and strength, and improves high-temperature hardness and strength. Compounds of vanadium are utilized in the chemical, petroleum, glass, and ceramics industries.

Vanadium is produced mostly as a byproduct or coproduct of uranium. Although vanadium ore never has been produced commercially in Appalachia, there are processing plants in the Region.

In Appalachia, vanadium minerals occur in (1) uranium-bearing sandstone in Pennsylvania; known deposits are small, contain little vanadium, and seem to offer no potential for vanadium production, (2) titaniferous magnetite occurring as veins in gneiss and schist in northwestern North Carolina and eastern Tennessee; vanadium content is erratic and quite low, and (3) flake graphite deposits in schist of Precambrian age in Alabama; vanadium bearing graphite varies considerably in vanadium content and probably could be recovered only as a byproduct of another commodity.

PART 2. - THE MINERAL INDUSTRY IN WATER SUBREGIONS

INTRODUCTION

The Office of Appalachian Studies, U.S. Army Corps of Engineers designated 10 Water Subregions (fig. 1 - 1) for purposes of planning the development of water and related resources in Appalachia. Each Water Subregion is a group of counties representing a unit with more or less uniform and specific hydrologic and economic problems. The Appalachian Region is composed of Subregions A through J, inclusive. Table 2 - 1 shows the value of minerals produced in each Water Subregion during the period 1961-65. Table 2 - 2 shows the distribution of 1960 employment in mineral-related industries, by Water Subregions, with projections for the years 1980 and 2000.

The Bureau of Mines prepared a report on the mineral industry of each Water Subregion. Production of mineral commodities is discussed for the years 1961-65, and predictions are made concerning the future of the industry. Values of mineral commodities expressed in 1958 constant dollars were computed using deflators developed by the U.S. Bureau of Mines.

Supplementary tables containing counties added in October 1967 were added to the reports on Subregions B, E, and I.

TABLE 2 - 1. - Value of mineral production in the Appalachian Region, 1961-65

Water Subregion	Year				
	1961	1962	1963	1964	1965
Value of mineral production (thousand 1958 constant dollars)					
A	133,213	131,334	149,760	137,747	117,825
B	153,145	155,901	170,931	198,618	210,057
C	13,138	12,715	12,589	13,497	13,027
D	13,774	14,355	11,774	11,400	11,796
E	196,233	199,256	195,664	214,242	224,772
F	637,007	659,985	695,776	750,054	787,904
G	746,961	779,158	865,483	899,851	938,237
H	74,375	80,194	79,402	73,393	80,436
I	53,182	62,422	61,647	62,462	62,075
J	254,679	250,337	261,252	269,525	294,227
Total	2,275,707	2,345,657	2,504,278	2,630,789	2,740,356
Distribution of value (percent)					
A	5.9	5.6	6.0	5.3	4.3
B	6.7	6.7	6.8	7.6	7.7
C	.6	.5	.5	.5	.5
D	.6	.6	.5	.4	.4
E	8.6	8.5	7.8	8.1	8.2
F	28.0	28.1	27.8	28.5	28.8
G	32.8	33.2	34.5	34.2	34.2
H	3.3	3.4	3.2	2.8	2.9
I	2.3	2.7	2.5	2.4	2.3
J	11.2	10.7	10.4	10.2	10.7
Total	100.0	100.0	100.0	100.0	100.0

TABLE 2 - 2. - Total employment and employment in mineral-related industries, 1960-2000 by Water Subregions[1/]

Subregion	Employment			Change in employment				Percent of total employment		
				1960-1980		1980-2000				
	1960	1980	2000	Amount	Pct.	Amount	Pct.	1960	1980	2000
				Total Employment						
A	312,832	362,102	445,845	+49,270	+15.7	+83,743	+23.1	-	-	-
B	777,429	994,460	1,251,556	+217,031	+27.9	+257,096	+25.9	-	-	-
C	21,168	24,875	28,460	+3,707	+17.5	+3,585	+14.4	-	-	-
D	245,660	386,281	532,717	+140,621	+57.2	+146,436	+37.9	-	-	-
E	669,642	952,330	1,329,010	+282,688	+42.2	+376,680	+39.6	-	-	-
F	1,609,581	1,951,396	2,314,519	+341,815	+21.2	+363,123	+18.6	-	-	-
G	784,964	967,089	1,240,107	+182,125	+23.2	+273,018	+28.2	-	-	-
H	67,230	78,932	106,554	+11,702	+17.4	+27,622	+35.0	-	-	-
I	132,348	146,152	197,329	+13,804	+10.4	+51,177	+35.0	-	-	-
J	854,615	1,271,308	1,877,605	+416,693	+48.8	+606,297	+47.7	-	-	-
Total	5,475,469	7,134,925	9,323,702	+1,659,456	+30.3	+2,188,777	+30.7	-	-	-
				Employment in Mining						
A	15,188	5,820	4,750	-9,368	-61.7	-1,070	-18.4	4.9	1.6	1.1
B	15,077	11,430	9,890	-3,647	-24.2	-1,540	-13.5	1.9	1.1	.8
C	202	200	200	-2	-1.0	0	0	1.0	.8	.7
D	1,117	659	1,288	-458	-41.0	+629	+95.4	.5	.2	.2
E	12,289	7,694	5,816	-4,595	-37.4	-1,878	-24.4	1.8	.8	.4
F	51,610	33,794	27,031	-17,816	-34.5	-6,763	-20.0	3.2	1.7	1.2
G	67,316	39,769	30,148	-27,547	-40.9	-9,621	-24.2	8.6	4.1	2.4
H	8,044	6,626	7,088	-1,418	-17.6	+462	+7.0	12.0	8.4	6.7
I	10,085	5,420	4,840	-4,665	-46.3	-580	-10.7	7.6	3.7	2.5
J	24,735	22,588	26,248	-2,147	-8.7	+3,660	+16.2	2.9	1.8	1.4
Total	205,663	134,000	117,299	-71,663	-34.8	-16,701	-12.5	3.8	1.9	1.3
				Employment in Construction						
A	15,196	18,220	22,775	+3,024	+19.9	+4,555	+25.0	4.9	5.0	5.1
B	42,410	50,013	57,979	+7,603	+17.9	+7,966	+15.9	5.5	5.0	4.6
C	1,255	1,530	1,670	+275	+21.9	+140	+9.2	5.9	6.2	5.9
D	28,633	45,299	65,688	+16,666	+58.2	+20,389	+45.0	11.7	11.7	12.3
E	44,746	64,109	83,818	+19,363	+43.3	+19,709	+30.7	6.7	6.7	6.3
F	82,638	106,495	129,876	+23,857	+28.9	+23,381	+22.0	5.1	5.5	5.6
G	46,487	58,789	76,754	+12,302	+26.5	+17,965	+30.6	5.9	6.1	6.2
H	4,446	6,026	8,330	+1,580	+35.5	+2,304	+38.2	6.6	7.6	7.8
I	8,281	11,027	13,685	+2,746	+33.2	+2,658	+24.1	6.3	7.5	6.9
J	61,513	86,492	118,749	+24,979	+40.6	+32,257	+37.3	7.2	6.8	6.3
Total	335,605	448,000	579,324	+112,395	+33.5	+131,324	+29.3	6.1	6.3	6.2
				Employment in the Petroleum Industry						
A	158	-	-	-158	-100.0	-	-	0.1	-	-
B	322	44	25	-278	-86.3	-19	-43.2	(2/)	(2/)	(2/)
C	-	-	-	-	-	-	-	-	-	-
D	66	-	-	-66	-100.0	-	-	(2/)	-	-
E	978	500	500	-478	-48.9	0	0	.1	0.1	(2/)
F	5,219	3,690	2,142	-1,529	-29.3	-1,548	-42.0	.3	.2	0.1
G	2,517	2,418	2,610	-99	-3.9	+192	+7.9	.3	.3	.2
H	251	440	440	+189	+75.3	0	0	.4	.6	.4
I	441	360	360	-81	-18.4	0	0	.2	.2	.2
J	331	-	-	-331	-100.0	-	-	(2/)	-	-
Total	10,283	7,452	6,077	-2,831	-27.5	-1,375	-2.1	.2	.1	.1
				Employment in Primary Metals Industries						
A	6,546	7,896	9,800	+1,350	+20.6	+1,904	+24.1	2.1	2.2	2.2
B	24,664	25,436	25,260	+772	+3.1	-176	-.7	3.2	2.6	2.0
C	20	360	540	+340	+1,700.0	+180	+50.0	.1	1.4	1.9
D	740	538	725	-202	-27.3	+187	+34.8	.3	.1	.1
E	41,685	42,974	38,608	+1,289	+3.1	-4,366	-10.2	6.2	4.5	2.9
F	204,270	201,868	180,790	-2,402	-1.2	-21,078	-10.4	12.7	10.3	7.8
G	31,572	47,493	60,690	+15,921	+50.4	+13,197	+27.8	4.0	4.9	4.9
H	308	-	-	-308	-100.0	-	-	.5	-	-
I	195	121	104	-74	-37.9	-17	-14.0	.1	.1	.1
J	16,744	20,634	20,601	+3,890	+23.2	-33	-.2	2.0	1.6	.1
Total	326,744	347,320	337,118	+20,576	+6.3	-10,202	-2.9	6.0	4.9	3.6

1/ Total industry employment data from Office of Business Economics, Department of Commerce.
2/ Less than 0.1 percent.

THE MINERAL INDUSTRY OF WATER SUBREGION A

by

R. J. Leary[1/] and James R. Kerr[2/]

ABSTRACT

Water Subregion A includes seven counties in northeastern Pennsylvania within the Delaware and Susquehanna River Basins. Eighty percent of the Nation's anthracite is mined here. In 1965 anthracite accounted for $111 million of the $118 million total value of mineral production. The remainder is mainly construction minerals, mostly consumed within the Region. Anthracite production has been in decline for many years, and there is no discernible development to arrest this trend. It is highly unlikely that the growth in demand for construction minerals can counteract the continued decline in anthracite production. Therefore, the overall outlook for the mineral industries in Water Subregion A is for continued decline in economic importance, both relatively and in dollar value.

INTRODUCTION

Water Subregion A consists of seven counties in northeastern Pennsylvania (fig. A-1). Carbon, Monroe, Pike, and Wayne Counties are within the Delaware River Basin. Lackawanna County is almostly entirely in the Susquehanna River Basin, as are most of Luzerne County and about half of Schuylkill County; the remaining areas of these counties drain to the Delaware River. Physiographically, this Subregion straddles the Valley and Ridge province and the Southern New York section of the Appalachian Plateau. Nowhere in Appalachia is the relation between physiography and mineral resources more clearly demarked. The Valley and Ridge province terminates along a northerly line through the eastern portions of Carbon, Luzerne, and Lackawanna Counties; this is also the terminus of the anthracite fields. The 1960 population was 884,381; total employment was 312,832, of which 15,188 were employed in mining (table A-1).

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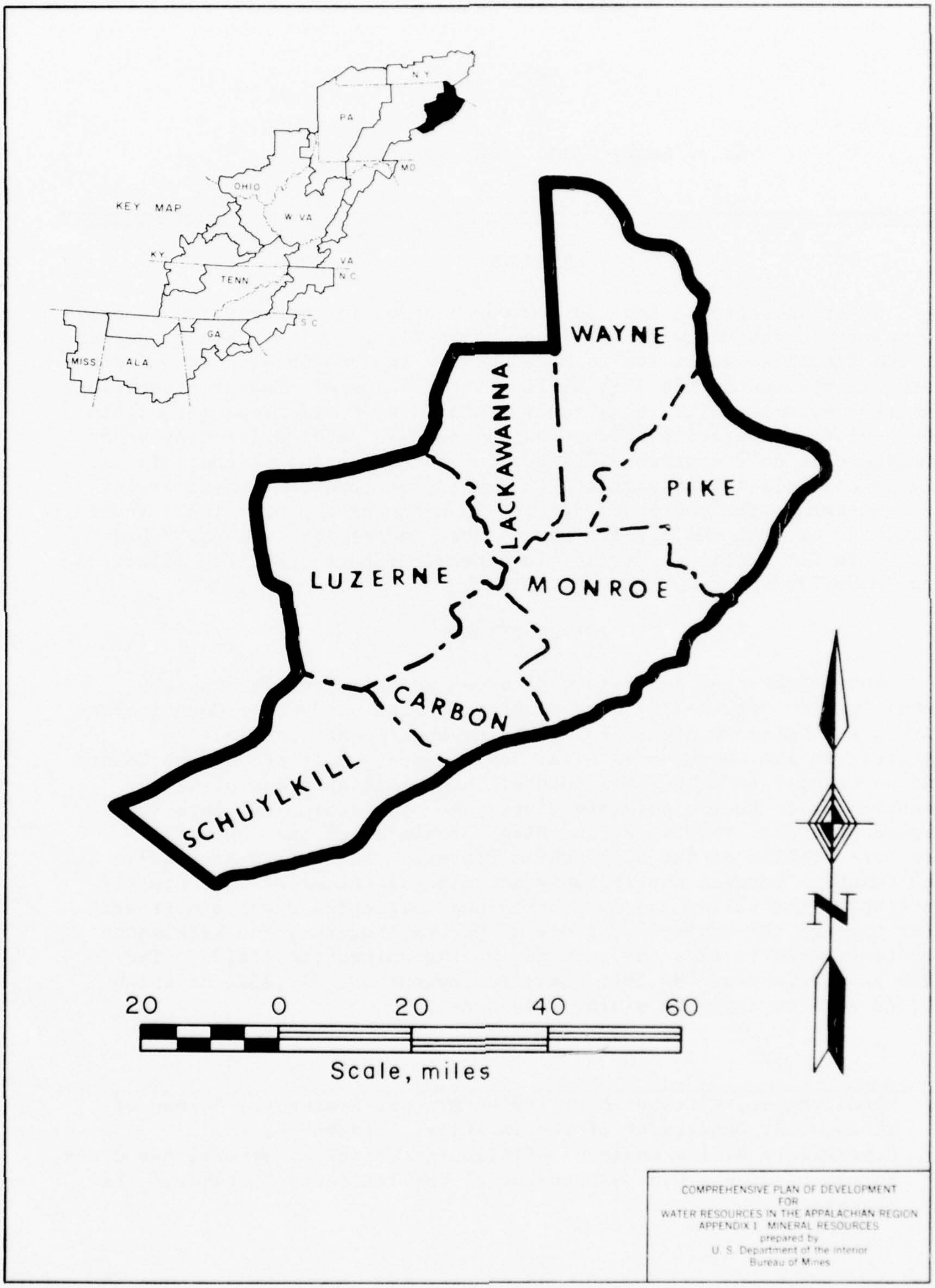

FIGURE A-1. - Water Subregion A.

TABLE A-1. - Employment in mineral-related industries, total employment and population, Water Subregion A, 1940-2000[1/]

Years	Mineral-related industries				Total employment	Total population
	Mining	Construction	Petroleum	Primary metals		
Employment and Population						
1940	82,479	10,071	-	-	299,622	1,100,015
1950	69,178	15,726	148	6,012	351,819	978,448
1960	15,188	15,196	158	6,546	312,832	884,381
1980	5,820	18,220	-	7,896	362,102	1,003,730
2000	4,750	22,775	-	9,800	445,845	1,215,872
Distribution of Employment (percent)						
1940	27.5	3.4	-	-	-	-
1950	19.7	4.5	(2/)	1.7	-	-
1960	4.9	4.9	0.1	2.1	-	-
1980	1.6	5.0	-	2.2	-	-
2000	1.1	5.1	-	2.2	-	-
Change in Employment						
1940-1960	-67,291	+5,125	(3/)	(3/)	+13,210	-
1960-1980	- 9,368	+3,024	-158	+1,350	+49,270	-
1980-2000	- 1,070	+4,555	-	+1,904	+83,743	-
Relative Change in Employment (percent)						
1940-1960	-81.6	+50.9	(3/)	(3/)	+4.4	-
1960-1980	-61.7	+19.9	-100.0	+20.6	+15.7	-
1980-2000	-18.4	+25.0	-	+24.1	+23.1	-

1/ Population and employment data from Office of Business Economics, Department of Commerce.
2/ Less than 0.1 percent.
3/ Indeterminate.

Subregion A is anthracite country. More than 80 percent of the anthracite produced in the United States is mined within this Subregion, and in 1965 it made up 94 percent of the mineral value produced in Subregion A (table A-2). Anthracite production has been declining since World War I; the 1965 output nationally was only one-seventh that of the peak year, 1917. Nonetheless the 1965 output in Subregion A was valued at $111 million (1958 constant dollars), a considerable factor in a population of 0.9 million. Other mineral production is mainly in construction minerals, mostly consumed within the Subregion. Mining constituted 5 percent of total employment in 1960; this is 2-1/2 times the average for the Appalachian Region and five times the national average in the same year. The localized importance of the mineral industry within the Subregion can be gathered from table A-3.

MINERAL RESOURCES OF SUBREGION A

Fuels

Anthracite

Over 80 percent of the Nation's anthracite is produced from four counties in Water Subregion A: Carbon, Lackawanna, Luzerne, and Schuylkill. The remaining three counties in the Subregion are northeast of the coal measures.

The industry dates back to the early 1800's. The first steam locomotive in this country--the "Stourbridge Lion"--was built for hauling anthracite. Industry structure is very complex, partly due to tradition, but mainly because anthracite occurs in folded rocks and thus gives rise to a large number of mining sites. In 1965 there were over 400 mines in Subregion A, ranging from two-man operations to large integrated mines and preparation facilities employing hundreds of men. Many small operators sell run-of-mine coal to preparation plants, and a number of these plants depend entirely on the independent producers. Most of the production has originated in underground mines, but strip mining has grown in importance, until, in 1965, it accounted for about 40 percent of the total output. The following secondary sources of anthracite have also been developed: Reclaiming fine anthracite from old culm banks and dredging from streams below old washeries. In years past these fines accumulated because larger coal was required for the space-heating market. Fines, however, require a minimum of preparation for sale in the electric power generation market, and anthracite thus recovered now accounts for about 25 percent of the entire anthracite market.

Anthracite marketing patterns are also complex. Output from small preparation plants tends to be shipped by truck, either by retail merchants or by haulers delivering to commercial or industrial accounts. Larger plants tend to ship by rail to wholesale brokers or directly to larger industrial accounts.

The anthracite counties in Subregion A and neighboring counties to the southwest in Subregion B (Northumberland, Columbia, Snyder, and Susquehanna) combine to produce 95 percent of the Nation's anthracite,

TABLE A-2. - Mineral production and value in Water Subregion A, 1961-65

Mineral	1961	1962	1963	1964	1965
Production, thousand short tons:					
Clays	(1/)	300	(1/)	180	209
Coal (anthracite)	14,219	14,042	14,897	13,261	11,783
Gem stones	NA	NA	NA	-	-
Peat	(1/)	23	(1/)	25	35
Sand and gravel	969	1,099	1,171	1,547	2,076
Stone	864	1,346	1,538	1,561	1,509
Value, thousand constant 1958 dollars:					
Clays	(1/)	244	(1/)	165	190
Coal (anthracite)	129,108	126,507	144,717	131,941	111,241
Gem stones	(1/)	(2/)	(1/)	-	-
Peat	(1/)	299	(1/)	280	404
Sand and gravel	1,327	1,426	1,481	1,967	2,645
Stone	2,327	2,858	3,170	3,394	3,345
Items that cannot be disclosed: Clays (1961,63), gem stones (1961-63), and Peat (1961,63)	451	-	392	-	-
Total	133,213	131,334	149,760	137,747	117,825

NA Not available.
1/ Included with value of "Items that cannot be disclosed."
2/ Less than $500.

TABLE A-3. - Value of mineral production in Water Subregion A, 1965, by counties

State and county	Value in current dollars	Minerals produced in 1965 in order of value
Pennsylvania:		
Carbon	$4,624,670	Anthracite, stone, sand and gravel.
Lackawanna	W	Anthracite, sand and gravel, peat.
Luzerne	W	Do.
Monroe	655,616	Stone, sand and gravel, clay, peat.
Pike	-	-
Schuylkill	43,796,225	Anthracite, stone, sand and gravel, clay.
Wayne	713,085	Stone, sand and gravel, peat.
Undistributed	58,024,925	
Total	107,814,521	

W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."

80 percent in Subregion A and 15 percent in Subregion B. The remaining 5 percent comes from Berks, Dauphin, Lebanon, and Lancaster, the Pennsylvania counties which lie immediately to the southeast, but outside of Appalachia.

The major market for anthracite is in domestic space heating, which comprised more than 40 percent of the market in 1965. Public utilities and the iron and steel industry each consumed about 15 percent. Exports accounted for 12 percent, and the remainder of the production was sold for a variety of uses.

Resources are ample. Probable total recoverable resources of Pennsylvania anthracite for all the above mentioned counties in 1965 were 11.6 billion tons, three times the cumulative production to that year, and at the 1965 rate of production were sufficient for nearly a thousand years. Economically recoverable reserves are much smaller; much of the resources lie below the water table, and could be mined only after large-scale pumping.

The outlook for the anthracite industry is pessimistic. Unlike the bituminous coal industry which has successfully reduced production costs by mechanization, the anthracite industry remains plagued by high mining costs in its steeply pitching coal seams. Anthracite's main use has been as a domestic fuel, and that market has largely been preempted by convenience fuels, even in the anthracite region. As recently as 1950 anthracite accounted for 34 percent of the fuels consumed in major anthracite sales areas; by 1964 its share had dwindled to 8 percent, while fuel oil and natural gas had risen to 64 and 28 percent, respectively. In an era of unprecedented growth in energy consumption the anthracite market has declined not only relatively but in absolute magnitude. During the past 20 years production of anthracite in the United States has fallen from 60.5 million tons to 14.9 million tons. Subregion A, the leading anthracite area, has experienced the bulk of this decline.

Production will continue to decline, but at a slower rate. The projection for 1980 is 6.5 million tons of Pennsylvania anthracite, and in 2000, 4 million tons. No discernible developments to enlarge the market are foreseeable. Unfortunately, there is no technological basis for a radical breakthrough in mining technology, and there is no likelihood that the industry will create it--the division of the industry among so many small producers and their lack of capital preclude the organization and funding of an effective research and development program.

Peat

Peat deposits occur in the glaciated portion of the Subregion--Lackawanna, Monroe, Pike, and Wayne Counties, and most of Luzerne County. Although peat is classified by the Bureau of Mines as a fuel, all of the

production in Subregion A is sold for soil conditioning. The industry is composed of numerous producers ranging from two-man operations to an integrated mining, processing, and packaging plant.

Production and value in 1965 were 35,000 tons valued at $404,000 (1958 constant dollars). Production is growing and in 1965 there were eight producers in four counties: Lackawanna (1), Luzerne (4), Monroe (2), and Wayne (1). The leading peat-producing county in Pennsylvania in that year was Wayne, and Luzerne was second.

The principal market for peat is in soil conditioning, both the familiar bag of peat for home gardening and bulk shipments to commercial greenhouses, sod growers, and landscapers who purchase peat for soil improvement. Production in Appalachia began in 1958 and has grown strongly.

Knowledge of peat reserves is far from complete. Estimates are being revised upward as more bogs are measured. In 1964 the reserves in northeastern Pennsylvania (mostly in Subregion A) totaled 248 acres containing an estimated 2.1 million tons of peat. By 1966 the total area had increased to 1,000 acres. At least 50 years supply at the current rate of production has been established.

The outlook is for continued growth of the peat industry in Subregion A, situated close to populous markets and with ample peat resources. However, the impact of peat mining on the economy of the Subregion is small. Employment in peat mining in 1965 was less than 1 percent of total mining employment in the Subregion.

Bituminous Coal, Petroleum, and Natural Gas

No bituminous coal deposits or oil and gasfields are known in the Subregion.

Nonmetals - Construction Minerals

Stone, sand and gravel, and clay and shale are abundant in Subregion A, but occurrences are localized. In the Valley and Ridge province there are extensive deposits of limestone, sandstone, and clay and shale. Glacial drift and outwash overlie the Subregion except in Schuylkill County, and sand and gravel is abundant. Even in Schuylkill County the supply is adequate for local use.

Stone

In 1961-65, stone was quarried in all counties except Lackawanna (none in 1965) and Pike; in 1965, 14 quarries reported production. These are small operations conducted mainly for local consumption. Operations may be classified in three categories: Limestone for crushed products, sandstone for crushed products, and sandstone for dimension stone.

Crushed limestone was produced in 1965 at three quarries, one each in Luzerne, Schuylkill, and Monroe Counties. Major uses were concrete aggregate and roadstone. One quarry produced limestone for cement manufacture; another produced stone gravel.

Crushed sandstone was produced at eight quarries in four counties in 1965: Carbon (2), Luzerne (3), Schuylkill (2), and Wayne (1). Six of these quarries produce concrete aggregate and roadstone. Two quarries in Carbon and Schuylkill Counties, are captive operations of refractory manufacturers where, in the respective counties, quartzite and sandstone are produced and crushed for silica brickmaking outside the Appalachian Region.

Dimension sandstone is produced in Wayne County; three quarries were active in 1965. The product is used for flagstone.

Total output and value from stone operations in 1965 were 1.5 million short tons and $3.3 million (1958 constant dollars). Almost all of the output is consumed in construction. Resources of limestone are plentiful in the Valley and Ridge province. Sandstone is abundant throughout the entire Subregion.

Sand and Gravel

Sand and gravel pits were worked in all counties except Pike in 1961-65. In 1965, 14 were in operation, distributed as follows: Carbon (2), Luzerne (6), Lackawanna (1), Monroe (2), Schuylkill (1), and Wayne (2). These are small operations which depend almost entirely on construction for their market.

Production and value in 1965 totaled 2.1 million short tons and $2.6 million (1958 constant dollars), almost entirely for local markets. In that year 11 of the 14 pits produced sand and gravel--sand for building, and sand and gravel for paving. One also reported sales for fill and roofing. The other three produced sand for building and paving, one also supplying sand for industrial furnace uses.

Resources of sand and gravel in glacial drift and fluvial deposits are abundant throughout the region except for Schuylkill County. Sandstone and conglomerate occur extensively in Schuylkill and Carbon Counties, and are crushed for gravel. Between these sources, the resources for sand and gravel are ample for any forseeable needs.

Clay and Shale

Clay and shale occur in the Valley and Ridge province, but mainly as shales. In 1961-65 four pits and one coal refuse pile were mined in Luzerne (2), Monroe, and Schuylkill (2) Counties. All were captive operations. One pit each in Luzerne and Schuylkill Counties served two brick plants; the coal refuse operation in Luzerne County and the other pit in Schuylkill County supplied two lightweight

aggregate plants, and the Monroe County operation fed a nearby cement plant outside Appalachia.

Production and value in 1965 were 209,000 short tons and $190,000 (1958 constant dollars), all of it consumed at nearby manufacturing plants. The markets for brick and lightweight aggregate are mainly within the Subregion.

Deposits of clay and shale are common in the Valley and Ridge province, and resources are ample to supply the Subregion for the foreseeable future.

Summary

Production of construction minerals is comparatively low in Subregion A. On a per capita basis, the total production in 1965 was about two-thirds the Appalachian average and one-half the National average (table A-4).

TABLE A-4. - Per capita production of construction minerals, 1965, short tons

Mineral	United States1/	Appalachian Region	Subregion A
Stone.............	3.5	4.7	1.7
Sand and gravel...	4.7	1.8	2.3
Clay and shale....	.2	.2	.2
Total..........	8.4	6.7	4.2

1/ Exclusive of minerals consumed in cement production.

Total value of these minerals in Subregion A for 1965 was $6.2 million (1958 constant dollars), about $6.78 per capita. Because these minerals are so widely distributed and are low in value, the marketing area is circumscribed by the expense of transportation. Thus, each producer's marketing area usually is small, and there is not much competition from other Subregions. These minerals are used principally in highway and building construction. Overall, the market for these minerals is determined by the level of construction activity in Subregion A.

Resources of stone, sand and gravel, and clay and shale are adequate to support any forseeable demand to the year 2000 at least.

The outlook for construction minerals in Subregion A should be good. Office of Business Economics (OBE) projections for this Subregion

(table A-1) look forward to growths in population and in the proportion of the labor force employed in construction. Trends in highway and building construction are to greater consumption of materials per worker. The threefold effect of these projections is entirely in the direction of greater consumption of construction minerals.

Metals

Occurrence of vanadium and uranium at outcrops in the Valley and Ridge province are known, but no mining has been reported.

CONCLUSIONS

Continued decline in economic importance is the prospect for the mineral industry of Subregion A, both relatively and in absolute terms. The projected decline in Pennsylvania anthracite production between 1965 and 1980 is the root of the problem.

THE MINERAL INDUSTRY OF WATER SUBREGION B

by

R. G. Clarke[1/]

ABSTRACT

Total value of mineral production in Subregion B in 1965 was \$202 million (current dollars). Bituminous coal comprised 44 percent and anthracite 9 percent of the total value. Stone, sand and gravel, cement, and lime were also important. Mining employment is projected to decrease by 24 percent from 1960 to 1980 and by 13 percent from 1980 to 2000; petroleum employment, while not numerically important, will also decrease. Other mineral-related industry employment is projected to increase.

INTRODUCTION

Water Subregion B contains 44 counties in four States; the mineral industry data of 43 of these counties are used in the Subregion report. The Subregion includes 11 counties in New York, of which 10 are used[2/]; 22 in Pennsylvania; three in Maryland; and eight in West Virginia (fig. B-1). The Subregion embraces those portions of the Susquehanna and the Potomac River Basins that lie within the Appalachian Region. It also includes along its margin small segments of the Delaware and Hudson River Basins in the northeast, Lake Ontario drainage on the north, and the Ohio River Basin on the west. Two physiographic provinces are present in the Subregion. The northern half of Subregion B, above Lock Haven, Pa., is within the southern New York, Catskill, and Allegheny Mountain sections of the Appalachian Plateaus province. Much of the southern half of the Subregion lies within the Valley and Ridge province, except for a few eastern counties and a portion of Washington County, Md., which are within the Piedmont Plateau province. The Allegheny Mountain section of the Appalachian Plateaus province extends into the counties of Cambria and Somerset, Pa., Garrett, Md., and Mineral and Grant, W. Va.

1/ Mineral specialist, Pittsburgh Office of Mineral Resources, Bureau of Mines, U.S. Department of the Interior, Pittsburgh, Pa.

2/ Schoharie County, N. Y., was added to the Appalachian Region study October 1967.

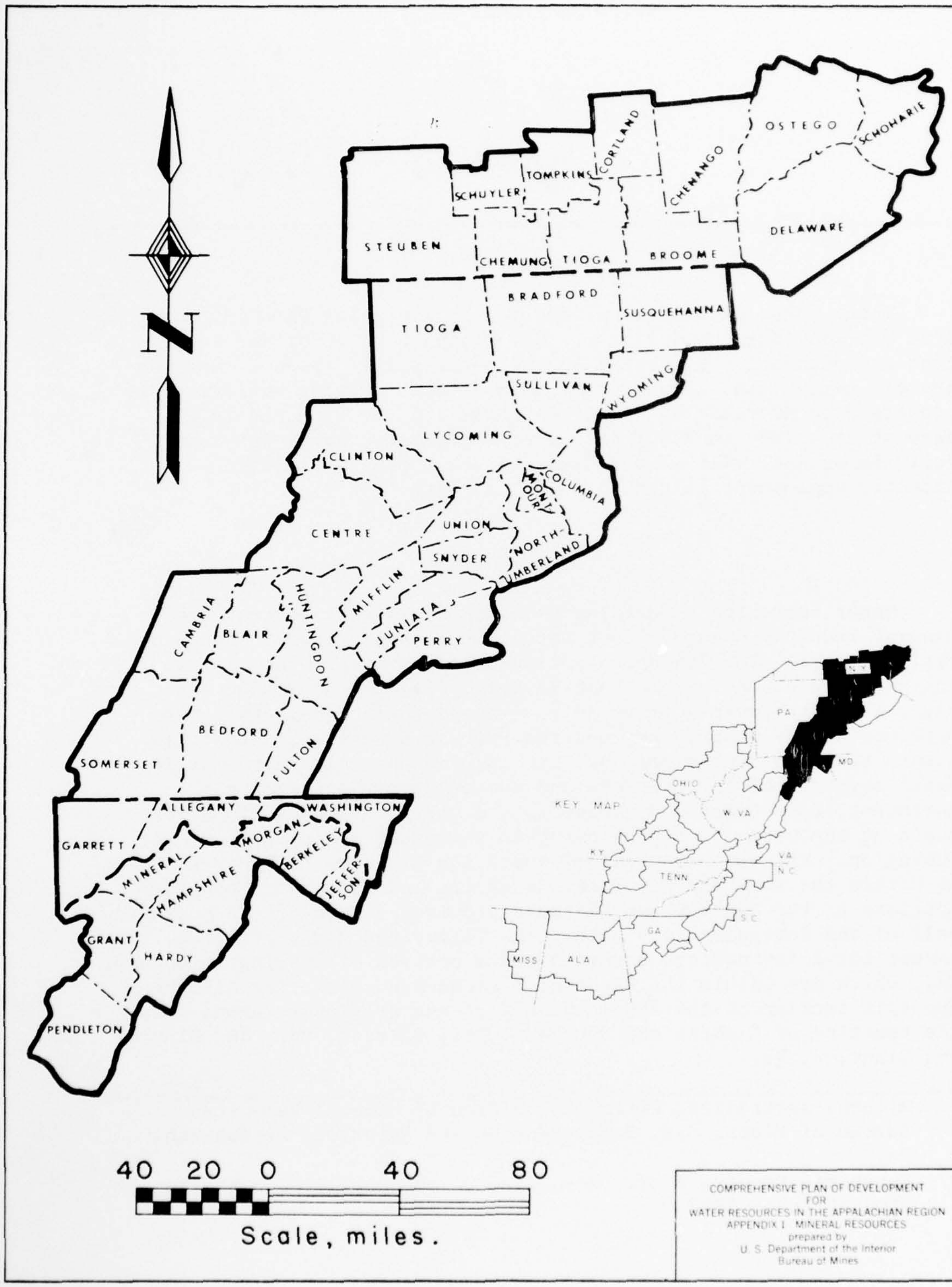

FIGURE B-1. - Water Subregion B.

The 1960 Subregion population was 2,220,853; total employment was 777,429, and mining employment was 15,077 (table B-1).

Mineral production in 1965 was valued at $202 million (current dollars) (table B-3). Value of production in 1958 constant dollars (table B-2) was $210 million, which was 7.7 percent of the Appalachian total. On a per capita basis, the importance of the mineral industry is much less than in Appalachia as a whole.

According to Office of Business Economics (OBE) employment data for Subregion B, mining employment in 1960 was 0.3 percent of the total in New York counties, 3.5 percent in Pennsylvania counties, and 1.5 percent in Maryland-West Virginia counties.

In 1965, mineral production was reported in 43 counties; seven counties accounted for two-thirds of the mineral value produced. About one-third of total Appalachian salt production came from Schuyler and Tompkins Counties, N. Y.; one-sixth of the anthracite production, from Columbia, Northumberland, and Sullivan Counties, Pa.; one-sixth of the cement, from Washington County, Md., and Berkeley County, W. Va.; and 4 percent of the bituminous coal from Cambria and Somerset Counties, Pa. The mines and plants that produce most of the glass sand are in Bedford, Huntingdon, and Mifflin Counties, Pa. About 40 percent of the lime produced in Appalachia was from Centre, Columbia, Juniata, Mifflin, Northumberland, and Snyder Counties, Pa. These mineral industries provide a better-than-average mineral base for industrial growth in the Subregion. The proximity to large metropolitan areas along the eastern seaboard and the existence of a well-developed transportation network to serve the Washington to New York City megalopolis are favorable for the mineral industry of Subregion B.

MINERAL RESOURCES OF SUBREGION B

Fuels

Anthracite

The Pennsylvania anthracite fields extend into Columbia, Northumberland, Sullivan, and Susquehanna Counties. Most of the anthracite is produced in Northumberland and Columbia Counties.

Production of anthracite in Subregion B, in 1965, totaled 2.2 million short tons valued at $18.9 million (1958 constant dollars), 15 percent of total anthracite produced. The largest market for anthracite, in 1965, was for domestic space heating which consumed

TABLE B-1. - Employment in mineral-related industries, total employment and population, Water Subregion B, 1940-2000 1/

Years	Mineral-related industries				Total employment	Total population
	Mining	Construction	Petroleum	Primary metals		
Employment and Population						
1940	46,940	30,427	(2/)	(2/)	636,307	2,034,390
1950	37,780	36,008	246	23,803	737,208	2,132,080
1960	15,077	42,410	322	24,664	777,429	2,220,853
1980	11,430	50,013	44	25,436	994,460	2,780,247
2000	9,890	57,979	25	25,260	1,251,556	3,413,913
Distribution of Employment (percent)						
1940	7.4	4.8	(2/)	(2/)	-	-
1950	5.1	4.9	(3/)	3.2	-	-
1960	1.9	5.5	(3/)	3.2	-	-
1980	1.1	5.0	(3/)	2.6	-	-
2000	.8	4.6	(3/)	2.0	-	-
Change in Employment						
1940-1960	-31,863	+11,983	(4/)	(4/)	+141,122	-
1960-1980	-3,647	+7,603	-278	+772	+217,031	-
1980-2000	-1,540	+7,966	-19	-176	+257,096	-
Relative Change in Employment (percent)						
1940-1960	-67.9	+39.4	(4/)	(4/)	+22.2	-
1960-1980	-24.2	+17.9	-86.3	+3.1	+27.9	-
1980-2000	-13.5	+15.9	-43.2	-.7	+25.9	-

1/ Population and employment data from Office of Business Economics, Department of Commerce.
2/ Data not available to Bureau of Mines.
3/ Less than 0.1 percent.
4/ Indeterminate.

TABLE B-2. - Mineral production and value in Water Subregion B, 1961-65[1/]

Mineral	1961	1962	1963	1964	1965
Production:					
Clays..................thousand short tons..	686	633	657	769	812
Coal (anthracite).............do..........	2,438	2,052	2,458	3,004	2,226
Coal (bituminous).............do..........	10,877	11,222	13,435	15,864	17,832
Lime..........................do..........	667	655	721	943	1,051
Natural gas...........million cubic feet...	3,578	2,472	1,633	1,373	408
Petroleum (crude)......thousand 42-gal. bbl.	1	1	(2/)	(2/)	(2/)
Sand and gravel........thousand short tons..	5,894	5,543	6,060	6,539	7,350
Stone.........................do..........	12,016	12,862	15,700	14,709	16,836
Value, thousand 1958 constant dollars:					
Clays.....................................	2,290	2,022	2,215	2,505	2,741
Coal (anthracite).........................	17,724	16,347	20,975	26,445	18,874
Coal (bituminous).........................	59,769	59,887	68,172	84,947	94,619
Lime......................................	8,984	8,697	9,500	12,056	13,688
Natural gas...............................	971	658	435	366	103
Petroleum.................................	4	4	2	2	1
Sand and gravel...........................	13,699	13,712	14,492	15,092	16,994
Stone.....................................	21,265	23,779	24,915	25,418	30,080
Items that cannot be disclosed: Cement (portland and masonry), gem stones (1961, 1963), iron ore (pigment material), peat (1963-65), potassium salts, salt, and tripoli.................	28,439	30,795	30,225	31,787	32,957
Total................................	153,145	155,901	170,931	198,618	210,057

1/ Excludes Schoharie County, N. Y.
2/ Less than 500 barrels.

TABLE B-3. - Value of mineral production in Water Subregion B, by States and counties, 1965

State and county	Value in current dollars	Minerals produced in 1965 in order of value[1]
Maryland:		
Allegany.......	$2,547,885	Bituminous coal, sand and gravel, stone, clay.
Garrett........	3,663,319	Bituminous coal, stone, natural gas, sand and gravel.
Washington.....	W	Cement, stone, clay, potassium salts.
New York:		
Broome.........	1,294,001	Sand and gravel, stone, clay.
Chemung........	W	Sand and gravel.
Chenango.......	304,000	Do.
Cortland.......	W	Do.
Delaware.......	1,239,743	Stone, sand and gravel.
Otsego.........	226,367	Do.
Schoharie[2]....	W	Cement, stone, clay, sand and gravel.
Schuyler.......	W	Salt, sand and gravel.
Steuben........	682,000	Sand and gravel.
Tioga..........	493,000	Do.
Tompkins.......	W	Salt, stone, sand and gravel.
Pennsylvania:		
Bedford........	W	Stone, bituminous coal, sand and gravel, lime.
Blair..........	2,180,478	Stone, clay, bituminous coal, sand and gravel.
Bradford.......	389,510	Sand and gravel, bituminous coal.
Cambria........	51,336,952	Bituminous coal, clay, sand and gravel, stone, iron ore (pigment material).
Centre.........	W	Lime, stone, bituminous coal, clay.
Clinton........	W	Bituminous coal, stone, clay.
Columbia.......	W	Anthracite, sand and gravel, lime, clay, peat, stone.
Fulton.........	W	Stone, sand and gravel.
Huntingdon.....	5,578,588	Sand and gravel, stone, bituminous coal, clay.
Juniata........	W	Stone, lime.
Lycoming.......	2,083,702	Stone, sand and gravel, bituminous coal, tripoli.
Mifflin........	W	Sand and gravel, stone, lime.
Montour........	W	Stone, sand and gravel.
Northumberland.	12,458,825	Anthracite, clay, stone, lime.

TABLE B-3. - Value of mineral production in Water Subregion B, by States and counties, 1965 (continued)

State and county	Value in current dollars	Minerals produced in 1965 in order of value[1]
Pennsylvania - Continued		
Perry..........	W	Stone.
Snyder.........	$455,499	Stone, sand and gravel, anthracite, lime.
Somerset.......	18,054,987	Bituminous coal, clay, stone, sand and gravel.
Sullivan.......	127,095	Anthracite.
Susquehanna....	927,083	Stone, anthracite.
Tioga..........	1,764,081	Bituminous coal, sand and gravel, stone.
Union..........	W	Stone.
Wyoming........	758,817	Sand and gravel, stone.
West Virginia:		
Berkeley.......	18,951,730	Cement, stone, lime, clay.
Grant..........	W	Bituminous coal, stone.
Hampshire......	-	-
Hardy..........	40,886	Stone.
Jefferson......	4,986,004	Stone, lime.
Mineral........	725,336	Bituminous coal, stone.
Morgan.........	W	Sand and gravel.
Pendleton......	964,951	Stone, lime.
Undistributed....	70,132,917	
Total........	[2] 202,367,756	

W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."

1/ Excludes petroleum that cannot be assigned to specific counties in Pennsylvania and natural gas in West Virginia; included with "Undistributed."

2/ Schoharie County, N. Y., added to Water Subregion B after original compilation. Value is not included in the total.

more than 40 percent of the total anthracite production. Public utilities and the iron and steel industry each consumed about 15 percent. Exports accounted for 12 percent, and the remainder of the anthracite production was sold for a variety of uses.

The outlook for anthracite is pessimistic. Anthracite's main market, domestic fuel, has largely been displaced by oil and gas. In an era of unprecedented growth in energy consumption the anthracite market has declined. During the past 20 years production of anthracite in the United States has fallen from 60.5 to 14.9 million tons. Subregion B has shared in this decline. Projections by the Bureau of Mines indicate that Pennsylvania anthracite production will continue to decline.

Bituminous Coal

Bituminous coal mining is the largest of the mineral industries of Subregion B; in 1965, it accounted for 44 percent of the total value of mineral output. Production was reported from 14 counties in Pennsylvania, Maryland, and West Virginia in the western half of the Subregion (table B-3). The Appalachian Coal Basin extends into Subregion B where the physiographic boundary of the Appalachian Plateaus province coincides in most places with the eastern margin of the Basin. The Georges Creek bituminous coal field in Maryland and West Virginia also lies within the Plateaus. One small bituminous coal field, the Broadtop, in southern Pennsylvania, lies in the Valley and Ridge province.

Production in Subregion B increased from 10.9 million tons in 1961 to 17.8 million tons in 1965 (table B-2), a gain of 63 percent. At the same time, the unit value of bituminous coal was declining. The rise in total value from $59.8 million (1958 constant dollars) in 1961 to $94.6 million (1958 constant dollars) signified a 3 percent decline in unit value from $5.50 in 1961 to $5.32 per ton in 1965. Bituminous coal valued at least at $1 million was produced in each of 10 counties in 1965; Allegany and Garrett, Md.; Bedford, Cambria, Centre, Clinton, Lycoming, Somerset, and Tioga, Pa.; and Grant, W. Va. Cambria led with 8.9 million tons valued at $52 million (current dollars), and Somerset was second with 3.7 million tons valued at $16.6 million (current dollars). Two other counties produced over 1 million tons, and three counties reported less than 1 million, but more than 500,000 tons, in 1965. About 65 percent of the production came from underground mines, 34 percent from strip mining and 1 percent from auger mining. Of the approximately 400 mines in operation in 1965, 60 percent were underground; 39 percent, strip; and 1 percent, auger. The growth of bituminous coal mining in 1961-65 in Subregion B paralleled the growth in the Appalachian Region. As a result, the Subregion continued to account for 4 to 5 percent of the total production and value of bituminous coal reported for the Appalachian Region.

The size of output varies considerably per operation. In 1965, of the 69 operations reporting from Allegany and Garrett Counties, Md., one mine reported 203,400 tons, one mine reported 131,400 tons, and all others less than 100,000 tons down to one operation of 2,000 tons. Operations in Pennsylvania are similar in range of size to those of Maryland, but the number producing more than 100,000 tons per year is greater. Figures on mining in Grant and Mineral Counties, W. Va., are confidential.

The largest and most rapidly growing use of bituminous coal is for the generation of electricity. Second in importance is metallurgical coke. Some of the coal from the Pennsylvania and Maryland counties of the Subregion is low-volatile and is especially suitable for coking blends. Other uses include industrial applications, where coal is consumed in furnaces, dryers, rotary kilns, railroads, miscellaneous uses, and exports. The National market for electric power has doubled each decade since 1947 and the forecast is for continued growth at about the same rate.

In addition to more efficient extractive mining technology, the cost of transportation has become of central importance in the expansion of markets and the opening of new mines. The competitive distance for shipment of coal has been increased by the use of unit-trains which have been effective in reducing freight rates. Unit-trains are complete trains of assigned cars and locomotives operating on regularly scheduled cycles between specified origins and destinations. More efficient storage and loading facilities for unit-trains are being installed at gathering points for small mines as well as large ones. A mine-mouth generating plant at Mount Storm, Grant County, W. Va., was started in 1965 and further mine-mouth developments in Subregion B are foreseeable. The proximity of Subregion B to Atlantic Seaboard energy consuming markets ought to be reflected in a high share in the markets. Bituminous coal reserves of the Subregion are ample to meet anticipated demands.

Petroleum, Natural Gas, and Natural Gas Liquids

In the Appalachian Plateaus province, petroleum and natural gas are found in generally the same areas as is bituminous coal. In Subregion B, the wells are being depleted. Crude petroleum production decreased from about 1,000 barrels in 1961 to less than 500 barrels in 1965; the value decreased from $4,000 to less than $1,000 (table B-2). Natural gas production decreased from 3,578 million cubic feet to 408 million cubic feet, and the value decreased from $971,000 to $103,000 (1958 constant dollars).

The decline is expected by OBE to continue, resulting in negligible production, value, and employment by 1980.

Nonmetals

Sand and Gravel

Sand and gravel production was reported from 25 of the 43 counties in Water Subregion B during each year in the period 1961-64. In 1965, 62 operations were reported in 27 counties (table B-3). Leading counties in decreasing order of 1965 output were Morgan, W. Va., Huntingdon, Pa., Broome, N. Y., Wyoming and Lycoming, Pa., Steuben, N. Y., and Mifflin, Pa. The seven counties contained one-third of the operations and accounted for two-thirds of the sand and gravel output in Water Subregion B.

The sand and gravel industry of the Subregion is unusual owing to the importance of industrial sand. Consumer specifications for industrial sand require closer control of chemical composition and sizing than specifications for construction sand. The markets for construction sand and gravel in 1965 were served by 58 operations in 24 counties. The National distribution of tonnage in 1965 was 97 percent for construction and 3 percent for industrial uses. However, industrial sand accounted for more than one-third of the 1965 sand and gravel production in Subregion B; two producers mined and processed sand for industrial purposes in four counties; Morgan, W. Va., Huntingdon, Lycoming, and Mifflin, Pa.

Production and value of sand and gravel in 1965 were 7.4 million tons and $17.2 million (current dollars). The production was 21 percent of the total Appalachian output in 1965. From 1961 to 1965 output of sand and gravel in Subregion B increased at the rate of 7 percent, which was about the same as the rate of growth for sand and gravel in the Appalachian Region. Per capita production of sand and gravel in Subregion B, in 1965, was 3.13 tons. Sand and gravel output in Appalachia was equal to a per capita production of 1.8 tons. In both instances, the per capita production was far below the National average of 4.7 tons in 1965.

Sand and gravel produced for construction purposes in Subregion B, as in most other areas, moves only short distances, because it is a low-valued commodity. The sources of supply are well distributed throughout the Subregion. Deposits suitable for industrial sand are localized; average unit value of product is more than three times that of construction sand and gravel. Industrial sand is sold over a wide marketing radius. In 1965, the industrial sand produced in Water Subregion B accounted for most of the Appalachian output, and more than one-tenth of the Nations's output.

Construction sand and gravel produced in Subregion B is sold for aggregate, ballast, and fill. Industrial sand is sold for glassmaking, refractories, grinding and polishing, molding, and traction.

According to OBE projections of employment (table B-1) the outlook for sand and gravel in Subregion B is good.

Stone

Stone quarrying is extensive in Water Subregion B. In 1965, there were 110 stone-producing operations, spread over 33 of the 43 counties of the Subregion. Leading counties in order of 1965 production were Centre, Pa., Washington, Md., Berkeley and Jefferson, W. Va., and Blair, Pa. The five counties accounted for more than 60 percent of the stone produced in Subregion B. The diversity of rock types within the Subregion is reflected strongly in the stone industry. Of the 110 quarries operating in 1965, 76 produced crushed limestone and one produced crushed dolomite, 20 produced dimension sandstone, and 13 produced crushed sandstone. The quarries ranged from small, intermittent operations producing a few hundred tons of dimension stone, to large-scale captive quarries in many of which the output exceeded a million tons of crushed stone annually. Most of the quarries either produced crushed stone for use in concrete aggregate, or for use by industry as metallurgical flux, cement, or lime. Dimension stone operations are for the most part, single-plant enterprises, but the marketing radius may be large depending on the architectural demand.

Production and value of stone, in 1965, were 16.8 million tons and $30.0 million (1958 constant dollars). The overall growth in stone production from 1961 to 1965 was 40 percent (table B-2). Production, in the Subregion in 1965, was 17 percent of the Appalachian output, up slightly from an average of 16 percent in the years 1961-64. Per capita production of stone in Subregion B, in 1965, was 7.2 tons compared with 4.7 tons in the Appalachian Region and 3.5 tons in the Nation. Considerable stone gravel is used as a substitute for natural gravel, and accounts for the high per capita production.

Uses and markets for stone produced in Subregion B are varied. Crushed limestone is sold for fill, roadstone, riprap, concrete aggregate, agricultural stone, metallurgical flux, cement, rock dust for coal mines, and lime. Crushed dolomite is calcined to produce deadburned dolomite, a refractory for steelmaking furnaces. Crushed sandstone is used as concrete aggregate, as industrial sand, and for manufacturing silica brick. Dimension sandstone is processed for use as rubble, rough construction, flagstone, and building stone. Crushed stone used directly in construction and agriculture is abundant throughout the Subregion.

In Subregion B, deposits of limestone, dolomite, and sandstone are sufficient to meet foreseeable needs.

The outlook for growth in stone production in Water Subregion B is good. OBE projections (table B-1) forecast a slight decline in the percentage of total employment engaged in construction. The growth rate projected for total employment is about the same as for Appalachia as a whole. Continued growth in the consumption of construction minerals is projected.

The demands for metallurgical lime are expected to grow in the next decade as a consequence of technological changeover in steel-making methods. Cement and lime produced within the Subregion are shipped to markets beyond the Subregion.

Clay and Shale

Clay and shale are distributed extensively in Subregion B, but deposits suitable for refractory manufacture are not common. In 1965, production of clay and shale was reported from 12 counties. The principal counties in decreasing order of output were Berkeley, W. Va., Northumberland, Pa., Washington, Md., and Somerset, Pa. These four counties accounted for more than 80 percent of the production in Subregion B.

The number of clay and shale operations in Subregion B was 31, in 1965, 15 in the four counties listed above, and the remaining 16 producers were located in eight other counties. Miscellaneous clay and shale accounted for more than three-fourths of the production, and fire and flint clay for most of the remainder. Kaolin production was a small proportion of the total. Nearly all the mining operations were captive, providing clay and shale to cement, brick, or clay product plants.

Clay and shale production in 1965 was 812,000 tons valued at $2.7 million (1958 constant dollars). An analysis of the 1965 data shows values of clay and shale ranging from less than $1 per ton for cementmaking to more than $5 per ton for building brick; fire and flint clay sold for over $7 per ton. In the period 1961-65 production of clay and shale in Subregion B increased 19 percent compared with 12 percent in the Appalachian Region and 16 percent in the Nation. During this period both production and value in the Subregion were about 9 percent of the Appalachian Region totals.

The marketing area for captive clay and shale production is usually limited because it is consumed at the parent manufacturing plant. For clay and shale produced in Subregion B, the marketing areas for most of the principal manufactured products extend outside the Subregion.

About 30 percent of the clay and shale produced in Subregion B is used for cementmaking, about 25 percent for refractories. Most of

the remainder of the clay and shale output is used in the manufacture of building brick and heavy clay products. A small quantity is used as a filler for linoleum and fertilizer.

The outlook for clay and shale in Water Subregion B is essentially parallel to the outlook for construction. At least three-fourths of the output is classified as miscellaneous clay and shale, virtually all of it intended for construction products: cement, building brick, and heavy clay products. The remaining one-quarter, intended for firebrick manufacturing, is faced with declining markets for firebrick as a result of technological changes in industry.

Cement

The cement industry in Water Subregion B consists of two plants, one each in the counties of Washington, Md., and Berkeley, W. Va. Production and value of cement in Subregion B cannot be disclosed because the company data are confidential. In the 1961-65 period, the per capita production of cement in the Subregion was close to the average of that in the Appalachian Region which, in turn, was about 30 percent greater than the national average. Cement production and value have grown in the 1961-65 period at about the same rate as that experienced in the entire Appalachian Region, which was 15.8 percent growth in production and 12.6 percent growth in value. The smaller growth in value reflects a decline in value per unit of production, a consequence of intense competition for markets caused by the existence of three plants in nearby Carroll and Frederick Counties, Md., which are outside the Appalachian Region. The five plants market eastward to Maryland, District of Columbia, and northern Virginia. Shipments are also made inside the Appalachian Region to western and central Pennsylvania and West Virginia. The marketing area to the northeast and northwest is limited by the large number of cement plants operating in eastern and western Pennsylvania.

Both portland and masonry cement are manufactured in Subregion B; the ratio, tonnagewise, is about 9 to 1. About 66 percent of the 1965 production of portland cement was used in ready-mixed concrete. Concrete product manufacture used 21 percent. Both were significantly higher than the National averages which were 59 percent for ready-mixed concrete and 14 percent for concrete products.

The principal mineral raw materials used in cement manufacture are limestone and clay or shale which are abundantly available in the Subregion.

The outlook for cement demand is good. The OBE projections of construction employment decline slightly as a percentage of total employment (table B-1), but technological improvements in construction

employee. The demand for cement should increase with the rise in population.

Lime

Subregion B is the most important producer of lime in Appalachia. Output in the Subregion increased 50 percent from 1961 to 1965; in the same period the Subregion share of Appalachian production rose from 35 percent to 42 percent, and of value, from 38 percent to 43 percent. Production in 1965 was reported from 13 operations in 10 counties in the Subregion, but 99 percent was produced by six plants in Centre County, Pa., and Jefferson, Berkeley, and Pendleton Counties, W. Va. These large-scale operations are mainly concerned with producing high-calcium quicklime for industrial markets, such as chemical, refractory, steel, pulp, paper, and construction. By contrast, the seven small operations in seven counties (the remaining 1 percent of total production) manufactured hydrated lime mainly for local consumption in agriculture.

The reserves of limestone in the Subregion are ample to meet present and forecasted demands. More high-purity limestone is mined in Centre County, Pa., for metallurgical and chemical lime than in any other county in the Subregion. Berkeley and Jefferson Counties, W. Va., are the leading lime producing counties in West Virginia and rank second and third in Subregion B. The outlook for the industry is good.

Minor Nonmetals[3/]

Salt

Salt is produced in Subregion B in two counties of New York. In 1965, salt was produced in Schuyler County from wells near Watkins Glen, and was used principally for industrial applications; and in Tompkins County, near Myers, rock salt was mined and used principally for highway ice control in New York, New Jersey, Massachusetts, Pennsylvania, and Virginia.

Reserves of rock salt and brine in other areas of Subregion B are available for future development.

Potassium Salts

Potassium sulfate was recovered as a byproduct from cement manufacture in Washington County, Md. It was sold for agricultural use.

3/ Production and value are concealed to avoid disclosing individual company data.

Tripoli

Tripoli (rottenstone) was produced in Lycoming County, Pa., and was sold for use as a filler and abrasive.

Peat

Peat was produced in Columbia County, Pa., and Garrett County, Md., for use as a soil conditioner.

Pigment Material

In 1965, in Cambria County, Pa., crude iron oxide pigments were recovered from streams receiving acid mine drainage from coal mines. The iron oxide was converted to a red pigment by calcination in a plant in Northampton County, Pa.

Other pigments, such as ocher, umber, and sienna were produced from the same sources but, due to the development of synthetic pigments, production was discontinued.

Metals

Subregion B was once the principal producer of iron ore in the United States. Since 1900, however, mining has been discontinued. Hematite (Fe_2O_3 plus impurities of SiO_2 and MgO), called "red ore," limonite ($2Fe_2O_3 \cdot 3H_2O$, a mixture of hydrous iron oxides), called "brown ore," carbonate ores (such as siderite, $FeCO_3$), and magnetite (Fe_3O_4) are iron ores which occur in the Subregion and could be exploited, if needed.

Ores of the ferro-alloy metals, such as manganese, chromium, and nickel, occur but are not mined at present because they are low-grade and deposits are small. Nonferrous metal ores, such as copper, lead, and zinc are present in the Subregion, but are not mined. There are reserves of high-alumina clays which may, in the future, be mined as a source of aluminum. No magnesium is produced but high-magnesium dolomites could become a source for that metal, if a process were to be developed.

CONCLUSIONS

The mineral industry is a smaller component of the economy in Subregion B than in the whole Appalachian Region. In 1965, the population of Subregion B was about 12.8 percent of the Appalachian Region, but the value of mineral production was only 7.7 percent of the total for the Region. In effect, the per capita production of minerals in the Subregion was about 60 percent of that of the

Appalachian Region. Parallel relationships were observed in employment; both mining and primary metal employment in 1960 in the Subregion were about half of the average for the Appalachian Region.

The importance of the mineral industries in Subregion B is, however, greater than the value and employment statistics suggest. The wide range of mineral resources can provide raw material for diverse mineral based manufacturing plants. In 1965, Subregion B was the source of production for 5 percent of the bituminous coal in the Appalachian Region; 31 percent of the sand and gravel, 17 percent of the stone, 9 percent of the clay, 65 percent of the salt, 42 percent of the lime, and 10 percent of the cement.

The distribution of mineral values in Subregion B was better balanced than that in Appalachia as a whole. Bituminous coal accounted for 45 percent of the total value of minerals in Subregion B, compared with 69 percent for the Appalachian Region as a whole. Comparisons, in percent, are as follows:

Mineral	Subregion B	Appalachian Region
Bituminous coal.	45	69
Stone...........	15	5
Cement..........	10	5
Sand and gravel.	8	2
Salt............	6	1
Other...........	16	18

The value of output by the mineral industry in Subregion B from 1961 to 1965 increased $57 million to $210 million (1958 constant dollars). The annual growth rate was 8 percent. Value of coal (bituminous and anthracite) production increased at an annual rate of 10 percent and that of all other mineral commodities increased at a rate of 6 percent.

THE MINERAL INDUSTRY OF WATER SUBREGION C

by

R. J. Leary[1/] and James R. Kerr[2/]

ABSTRACT

Water Subregion C embraces the Appalachian segment of the James River Basin, Virginia. Abundant deposits of limestone, clay and shale, and sandstone constitute the bulk of the mineral resources. The mineral industry is devoted almost entirely to mining and converting these minerals into materials for concrete and masonry construction. Mining and the mineral industries have a substantial impact on the economy. In 1965 the value of mineral production totaled $13 million (1958 constant dollars), equivalent to $220 per capita. Approximately three-fourths of the value results from minerals and mineral products shipped out of the Subregion, principally to the east and south. The Subregion is too small an economic unit for internal demand to affect the growth of its mineral industry appreciably; this growth depends principally on expansion of the construction industry outside the Appalachian Region.

INTRODUCTION

Water Subregion C embraces the Appalachian segment of the James River Basin and consists of five counties along the western margin of Virginia (fig. C-1), as follows: Alleghany, Bath, Botetourt, Craig, and Highland. It is bounded on the west and north by the West Virginia border, and on the east and south by the limit of the Appalachian Region; the southern boundary is a few miles north of Roanoke, Va. The headwaters of the James River rise in Subregion C, which physiographically lies within the Valley and Ridge province. The 1960 population was 57,085, total employment was 21,168, and mining employment, was 202 (table C-1).

Mining and the mineral industries have a larger impact on the economy of Subregion C than the employment in mining would indicate. In 1965 the value of mineral production was $13.2 million, equivalent to $13.0 million (1958 constant dollars), or $220 per capita (table C-2).

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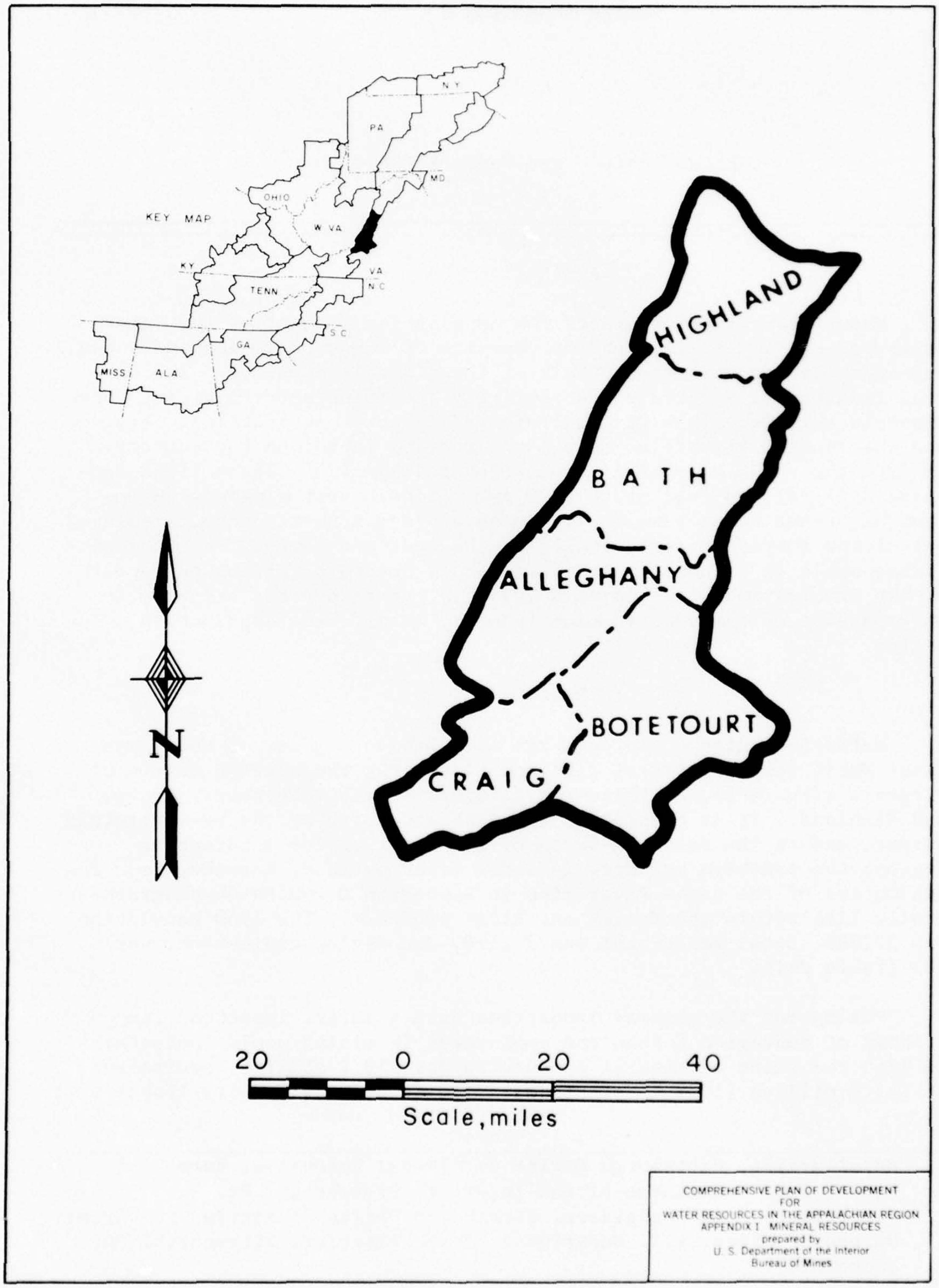

FIGURE C-1. - Water Subregion C.

TABLE C-1. - Employment in mineral-related industries, total employment, and population, Water Subregion C, 1940-2000 1/

Year	Mineral-related industries: Mining	Construction	Petroleum	Primary metals	Total employment	Total population
	Employment and Population					
1940	318	1,083	-	-	20,416	61,431
1950	239	1,443	-	9	21,566	58,517
1960	202	1,255	-	20	21,168	57,085
1980	200	1,530	-	360	24,875	66,100
2000	200	1,670	-	540	28,460	72,800
	Distribution of Employment (percent)					
1940	1.6	5.3	-	-	-	-
1950	1.1	6.7	-	(2/)	-	-
1960	1.0	5.9	-	0.1	-	-
1980	.8	6.2	-	1.4	-	-
2000	.7	5.9	-	1.9	-	-
	Change in Employment					
1940-1960	-116	+172	-	+20	+752	-
1960-1980	-2	+275	-	+340	+3,707	-
1980-2000	0	+140	-	+180	+3,585	-
	Relative Change in Employment (percent)					
1940-1960	-36.5	+15.9	-	(3/)	+3.7	-
1960-1980	-1.0	+21.9	-	+1,700.0	+17.5	-
1980-2000	0.0	+9.2	-	+50.0	+14.4	

1/ Population and employment data from Office of Business Economics, Department of Commerce.
2/ Less than 0.1 percent.
3/ Indeterminate.

TABLE C-2. - Value of mineral production in Water Subregion C, 1961-65[1/]
(thousand 1958 constant dollars)

Mineral	1961	1962	1963	1964	1965
Portland cement, masonry cement, clays, gem stones (1963), sand and gravel, and stone....................	13,138	12,715	12,589	13,497	13,027

1/ Details of mineral production statistics are withheld to avoid disclosing individual company confidential data.

TABLE C-3. - Value of mineral production in Water Subregion C, 1965

County	Value in current dollars	Minerals produced in 1965 in order of value
Alleghany....................	W	Stone, sand and gravel.
Bath..........................	$2,000	Sand and gravel.
Botetourt....................	W	Cement, stone, clay.
Craig........................	W	Sand and gravel.
Highland.....................	21,052	Stone, sand and gravel.
Undistributed...............	13,169,745	
Total......................	13,192,797	

W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."

Details of value of the minerals produced are confidential, and distribution of mineral production value among the counties of the Subregion cannot be fully disclosed (table C-3). The bulk of the mineral production value reported in table C-3 is produced in Botetourt County, with minor amounts coming from Alleghany, Bath, Craig, and Highland Counties.

The largest cement plant in Virginia is in Botetourt County, and this plant and the associated stone and clay production in the same county are responsible for much of the value of mineral production in the Subregion.

MINERAL RESOURCES OF SUBREGION C

Fuels

Thin, irregular coal beds crop out in the southwestern part of Botetourt County, Va., but no production has been reported in recent years.

Nonmetals

Abundant deposits of limestone, dolomite, sandstone, and shale occur in Subregion C, but sand and gravel resources are limited. The pegmatite belt of Southern Appalachia with its wide variety of nonmetallic minerals terminates south of this Subregion. A small production of barite was reported in 1915.

Stone

Activity in the stone industry in the Subregion is concentrated in Botetourt County where captive limestone is quarried and crushed for a large cement plant and several merchant limestone quarries also are active. The merchant segment of the industry is small; there were three to five such operations in this county in 1961-65. Limestone is produced regularly at two quarries in Alleghany County and one quarry in Highland County and intermittently in Bath and Craig Counties.

Production and value statistics for crushed limestone in Subregion C cannot be disclosed, but an approximation is possible. During 1961-65 more than three-quarters of the production originated in Botetourt County, and in 1965 the output in that county was 1.8 million tons valued at 2.8 million current dollars. The widespread occurrence of limestone deposits throughout the area precludes shipments much beyond the immediate vicinity of the quarries. The bulk of the market is established by local demand except for Botetourt County where quarries are located favorably for participation in the nearby Roanoke market outside the Appalachian Region.

In addition to the captive limestone production for cement manufacture, crushed stone is marketed for concrete aggregate, roadstone, metallurgical flux, agricultural stone, asphalt and fertilizer filler, railroad ballast, stone sand, and raw material for chemical use.

Limestone resources are adequate for all foreseeable demands; deposits 500 feet thick have been measured. Large deposits of dolomite and sandstone also are present.

The outlook for the Subregion's stone industry depends essentially on local construction activity and the demand for cement in the much wider marketing area of the cement plant. The bases for employment projections by the Office of Business Economics for the Subregion (table C-1) look forward to a growth in construction employment paralleling the growth of population through the year 2000. The consumption of stone in construction probably will grow faster than the construction employment data indicate because improvements in technology in the construction industry will increase the consumption of construction materials per unit of manpower.

Clay and Shale

Clay and shale are produced at three quarries in Botetourt County. No production was reported from other counties in the Subregion in 1961-65. All three operations are captive, producing feedstock for a cement plant, a brick plant, and a lightweight aggregate plant.

Although output and value statistics cannot be disclosed, Botetourt County ranks first among the clay-producing counties in the State. Clay is transported only short distances to the manufacturing plants, but finished products move in a much wider area both within and outside the Appalachian Region.

Clay and shale resources are abundant and adequate for all foreseeable demands.

The outlook for clay and shale is linked to the future demand for cement, masonry units, and other construction products. The magnitude of clay production is far beyond the present or potential demand of the population in the Subregion. As in the past, clay mining activity will depend largely on the strength of markets outside the Subregion.

Cement

Lone Star Cement Corporation operates a cement plant near Haymakertown in Botetourt County and manufactures both general-use and high-early-strength portland cement in four 9- by 340-foot rotary kilns. Masonry cement also is prepared and shipped. Raw materials for the plant are supplied by captive limestone and shale quarries located in the same county.

Cement shipments are mostly within Virginia and to North Carolina. Only a very small portion of the output is consumed within the Subregion. The plant is well situated to serve the middle and western segments of Virginia and North Carolina. The nearest competing plant is in Augusta County, Va., about 80 miles northeast; the nearest plants to the west

are in northeastern Tennessee and Ohio, and to the east on the Atlantic coast in Virginia and North Carolina.

Markets for cement shipments in the Virginia-North Carolina-South Carolina district in 1965 follow: ready-mixed concrete suppliers, 65 percent; concrete product manufacturers, 17 percent; highway contractors, 7 percent; other contractors, 5 percent; and building material dealers, 6 percent. Compared with the national average the proportion shipped to concrete product manufacturers is about 20 percent higher; to ready-mixed concrete suppliers, 9 percent higher; and to highway contractors, about 27 percent lower.

Clay and limestone resources in the Subregion for cement manufacture are ample for many years ahead.

The outlook for cement manufacture in the Subregion is difficult to assess. The plant is but one unit in a multiplant corporation with widespread operations. Thus, its existence and activity are dependent in the first instance on corporate-level decisions, and only secondarily on the demand for cement in the marketing area of the plant. It may be assumed that the demand for cement in its marketing area will depend on the level of construction activity and on the degree that concrete products share in that construction market. Cement is faced with severe competition in both building and highway construction. Other industries are aggressively competing in all segments of the building and structural market. In highway construction there is unremitting competition from bituminous concrete materials. Most of the cement from Subregion C is marketed outside Appalachia. The Subregion itself is too small to provide any substantial long-term market for the cement produced within it.

Sand and Gravel

Sand is produced in one pit in Craig County, the only continuing sand operation in the Subregion. Unprocessed gravel is produced intermittently in the four other counties. In 1961-65 gravel production was reported from three counties in 2 years, and in 1 year from a fourth.

Output and value statistics cannot be disclosed. However, the per capita production is well below that of the Appalachian Region.

Natural sand and crushed sandstone produced in Craig County is marketed for paving, building, filter beds and industrial use. Gravel produced in the other counties is used unprocessed for local road maintenance, and much of it is produced by the Virginia Department of Highways. Thus, the Craig County sand operation is the only one that may be classified as an industrial plant contributing to the growth of the Subregion's economy.

Sand and gravel resources in this Subregion are limited, but they are sufficient to serve local needs. There are, however, large deposits

of sandstone suitable for crushing. The outlook for sand production is good, if recent production trends are indicative of the future. More sand will likely be shipped for industrial uses, which are expected to grow with diversification of the economy in this and neighboring regions.

Metals

Deposits of low-grade iron ore occur in the Subregion and were mined on a small scale many years ago. Iron ore mining is unlikely in the foreseeable future; too many large, high-grade deposits exist elsewhere.

CONCLUSIONS

Abundant deposits of limestone, clay, shale, and sandstone constitute the bulk of the mineral resources of Water Subregion C. The mineral industry is devoted almost entirely to converting these minerals into materials for concrete and masonry construction: sand, crushed stone, cement, building brick, and lightweight aggregate.

Approximately three-fourths of the value of mineral production results from minerals and products shipped out of the Subregion, principally to the east and south. The Subregion is too small an economic unit to exert any great effect upon the growth of its mineral industry. Its future is dependent in the main on the growth of the construction industry within the marketing area, most of which is outside the Appalachian Region.

THE MINERAL INDUSTRY OF WATER SUBREGION D

by

Vernal A. Danielson[1/]

ABSTRACT

Value of mineral production in Subregion D in 1965 was $12.0 million, of which 94 percent was construction materials such as sand and gravel, crushed granite, and dimension granite. Feldspar, barite, and clay were also produced in the Subregion in 1965.

INTRODUCTION

Subregion D includes the counties of Barrow, Jackson, and Madison in Georgia; Alexander, Alleghany, Ashe, Burke, Caldwell, Davie, Forsyth, McDowell, Polk, Rutherford, Stokes, Surry, Wilkes, and Yadkin in North Carolina; and Anderson, Cherokee, Greenville, Oconee, Pickens, and Spartanburg in South Carolina. Figure D-1 is a map of the Subregion and shows its location within Appalachia. Major drainage areas partially within Subregion D are those of the Savannah, Yadkin-Pee Dee, Santee, Kanawha, Roanoke, Altamaha, Tennessee, and Chattahoochee River Basins.

Employment in mineral-related industries, total employment, and population in 1940, 1950, 1960, and projections to 2000 are listed in table D-1. In 1960 mining accounted for 0.5 percent of total employment; construction, 11.7 percent; petroleum, less than 0.1 percent; and primary metals, 0.3 percent.

Dimension and crushed stone, sand and gravel, feldspar, clay, and barite, in order of value, were produced in Subregion D in 1965 (table D-2). The total value of the mineral production was $11.8 million (1958 constant dollars). Other minerals produced in the 1961-63 period were copper, gem stones, gold, mica, silver, and vermiculite.

The value of mineral production in 1965 by counties is given in table D-3.

1/ Mining engineer, Knoxville Office of Mineral Resources, Bureau of Mines, U.S. Department of the Interior, Knoxville, Tenn.

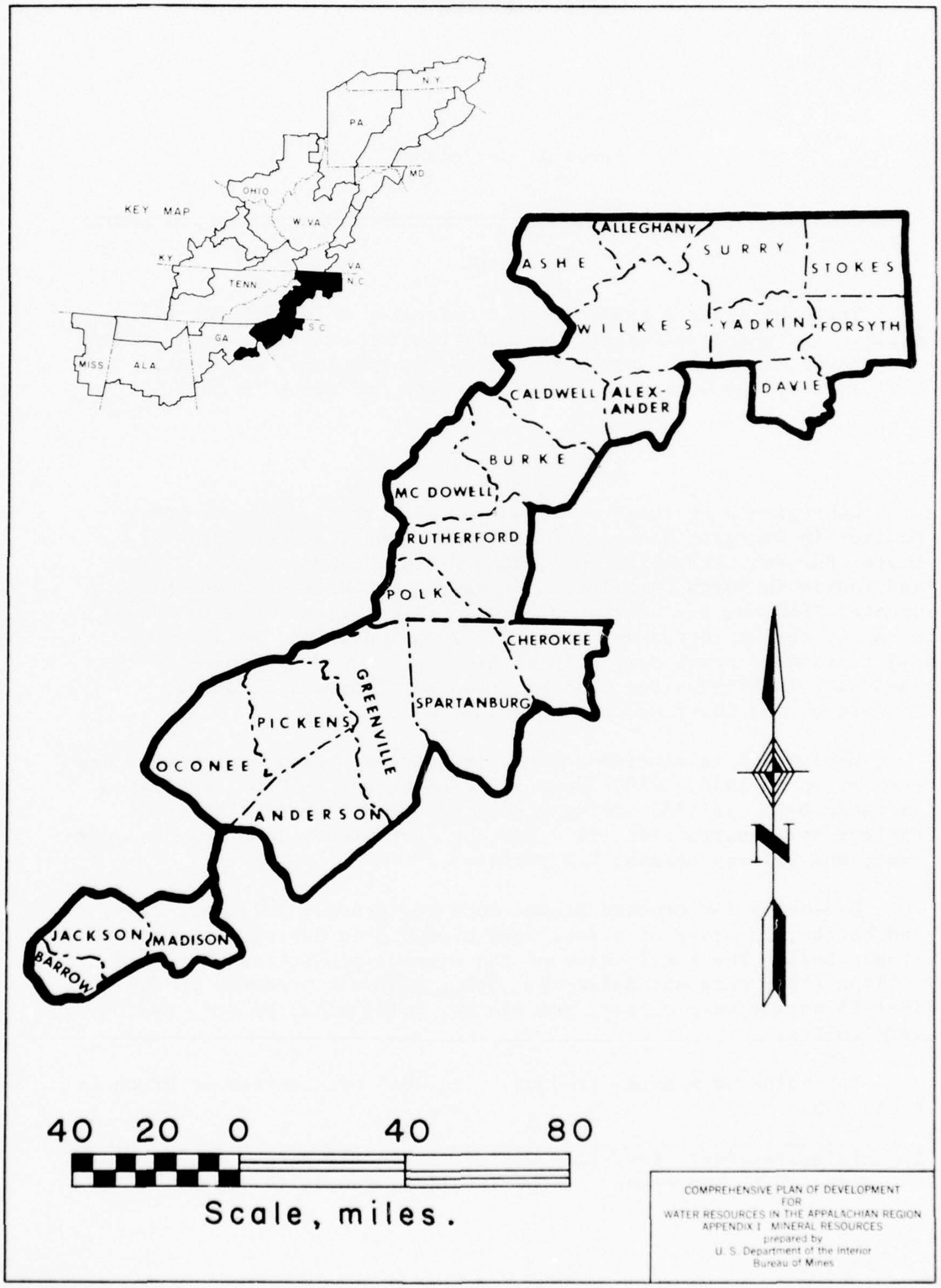

FIGURE D-1. - Water Subregion D.

TABLE D-1. - Employment in mineral-related industries, total employment and population, Water Subregion D, 1940-2000 1/

Years	Mineral-related industries				Total employment	Total population
	Mining	Construc-tion	Petroleum	Primary metals		
Employment and Population						
1940	680	11,576	-	-	176,046	975,320
1950	769	24,364	15	693	215,423	1,080,838
1960	1,117	28,633	66	740	245,660	1,204,130
1980	659	45,299	-	538	386,281	1,721,722
2000	1,288	65,688	-	725	532,717	2,460,858
Distribution of Employment (percent)						
1940	0.4	6.6	-	-	-	-
1950	.4	11.3	(2/)	0.3	-	-
1960	.5	11.7	(2/)	.3	-	-
1980	.2	11.7	-	.1	-	-
2000	.2	12.3	-	.1	-	-
Change in Employment						
1940-1960	+437	+17,057	(3/)	(3/)	+69,614	-
1960-1980	-458	+16,666	-66	-202	+140,621	-
1980-2000	+629	+20,389	-	+187	+146,436	-
Relative Change in Employment (percent)						
1940-1960	+64.3	+147.3	(3/)	(3/)	+39.5	-
1960-1980	-41.0	+58.2	-100.0	-27.3	+57.2	-
1980-2000	+95.4	+45.0	-	+34.8	+37.9	-

1/ Population and employment data from Office of Business Economics, Department of Commerce.
2/ Less than 0.1 percent.
3/ Indeterminate.

TABLE D-2. - Mineral production and value in Water Subregion D, 1961-65

Mineral	1961	1962	1963	1964	1965
Production:					
Copper..........short tons...........	5,928	3,602	-	-	-
Gem stones..........................	NA	NA	NA	-	-
Gold...........troy ounces..........	1,902	416	-	-	-
Mica:					
Scrap.........short tons...........	6	5	-	-	-
Sheet.........pounds...............	1,866	3,328	-	-	-
Sand and gravel.thousand short tons..	1,353	1,789	1,305	1,213	1,078
Silver..........troy ounces..........	25,311	5,894	-	-	-
Stone...........thousand short tons..	5,704	6,801	6,175	5,954	6,194
Value, thousand constant 1958 dollars:					
Copper..............................	3,145	1,947	-	-	-
Gem stones..........................	3	(1/)	1	-	-
Gold................................	66	14	-	-	-
Mica:					
Scrap.............................	(1/)	(1/)	-	-	-
Sheet.............................	13	36	-	-	-
Sand and gravel.....................	1,041	1,504	1,144	1,051	876
Silver..............................	23	6	-	-	-
Stone...............................	9,196	10,552	9,958	9,738	10,222
Items that cannot be disclosed: Barite, clays, feldspar, and vermiculite (1961, 1962).........	287	296	671	611	698
Total.................	13,774	14,355	11,774	11,400	11,796

NA Not available.
1/ Less than $500.

TABLE D-3. - Value of minerals production in Subregion D, by States and counties, 1965

State and county	Value in current dollars	Minerals produced in 1965 in order of value
Georgia:		
Barrow.........	-	-
Jackson........	-	-
Madison........	W	Granite.
North Carolina:		
Alexander......	$14,000	Sand and gravel.
Alleghany......	-	-
Ashe...........	W	Sand and gravel.
Burke..........	W	Granite, sand and gravel.
Caldwell.......	W	Do.
Davie..........	22,000	Sand and gravel.
Forsyth........	W	Granite, sand and gravel.
McDowell.......	W	Sand and gravel, granite.
Polk...........	W	Granite, sand and gravel.
Rutherford.....	41,000	Sand and gravel.
Stokes.........	W	Miscellaneous clay, sand and gravel.
Surry..........	W	Granite, traprock, sand and gravel.
Wilkes.........	W	Granite, sand and gravel.
Yadkin.........	W	Do.
South Carolina:		
Anderson.......	-	-
Cherokee.......	1,150,000	Limestone, barite, sand and gravel, miscellaneous clay.
Greenville.....	W	Granite, sand and gravel.
Oconee.........	-	-
Pickens........	W	Granite, sand and gravel.
Spartanburg....	W	Granite, feldspar, sand and gravel.
Undistributed....	10,733,097	-
Total.....	11,960,097	

W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."

Stone (dimension granite, crushed granite, crushed limestone, and crushed basalt and related rocks) was the most significant in value of production in 1965, amounting to 87 percent of the total mineral production. Sand and gravel was second in value with 7 percent, and feldspar, barite, and clay made up the remaining 6 percent.

The mineral industry is a minor factor in the economy of the Subregion. The chief mineral products, 94 percent of which are low unit value construction materials, are important only to the local areas in which they are both produced and used. There is little competition from surrounding areas, with the exception of dimension stone, barite, and feldspar, which can be shipped greater distances because of their higher unit values.

MINERAL RESOURCES OF SUBREGION D

Nonmetals

Barite

Barite was produced at King's Creek, Cherokee County, S. C., in 1965. This was the only barite production from Subregion D. The barite was mined by Industrial Minerals, Inc., and ground for use as rubber filler.

Clays

Clays were mined in two counties of the Subregion in 1965: Stokes in North Carolina and Cherokee in South Carolina. The clays were used for manufacture of heavy clay products such as pipe and building brick.

The clay is mined by open pit methods by Pine Hall Brick and Pipe Company in Stokes County, and by Broad River Brick Company in Cherokee County.

Feldspar

Feldspar was recovered from granite screenings by Spartan Minerals Company, Spartanburg County, S. C., in 1965. The source of the granite screenings was the Pacolet quarry of Campbell Limestone Company. The feldspar thus recovered was ground at the Pacolet Plant of the Spartan Minerals Company for use in glass and pottery manufacture and as rubber filler.

Gem Stones

Small quantities of gem materials were collected by various individuals in the Subregion during 1961-63, but none was reported for 1964-65. There is no recorded commercial production of gem materials.

Sand and Gravel

Sand and gravel was produced in the following counties in 1965: Alexander, Ashe, Burke, Caldwell, Davie, Forsyth, McDowell, Polk, Rutherford, Stokes, Surry, Wilkes, and Yadkin in North Carolina; and Cherokee, Greenville, Pickens, and Spartanburg in South Carolina.

The sand and gravel industry is widely distributed throughout the Subregion. Competition is on a local level from the crushed granite industry, since the two are interchangeable for most uses. Transportation cost is a major factor in the economics of the industry and limits the distance at which sand and gravel can be marketed profitably. Most sand and gravel is used within 25 miles of the point of production; this accounts for the wide distribution of the industry throughout the Subregion. There is a tendency toward greater utilization of portable plants, locating the sand and gravel operation as close as possible to points of consumption in order to minimize transportation costs.

Consumption of sand and gravel is expected to increase in view of expanded building and highway construction programs.

Stone

Crushed Granite

Crushed granite was produced in 11 counties of the Subregion in 1965: Burke, Caldwell, Forsyth, McDowell, Polk, Surry, Wilkes, and Yadkin in North Carolina; and Greenville, Pickens, and Spartanburg in South Carolina.

Like the sand and gravel industry, the crushed granite industry is widely distributed throughout the Subregion. Both industries have similar transportation problems and compete with each other for local markets as they are usually interchangeable.

Uses for crushed granite will remain essentially unchanged, but increased building and highway construction will necessitate expansion of present operations and development of new operations. Ample reserves are available in the Subregion to meet this demand.

Dimension Granite

Dimension granite was produced in two counties of the Subregion in 1965: Surry, in North Carolina, and Madison, in Georgia. The granite produced in Surry County was for rough and dressed monumental stone, paving blocks, curbstone, flagstone, and both rough and dressed architectural stone; that produced in Madison County was rough monumental granite, most of which was trucked to Elberton, Ga., for finishing.

Competition from alternate materials, such as glass, metals, ceramic tiles, plastic panels, and precast concrete panels has reduced markets for dimension stone. In addition, many newer cemeteries prohibit the use of stone monuments, further reducing markets. However, the growing use of dimension stone panels and veneers as facing for buildings should partially offset the reduced demand.

Crushed Limestone

Crushed limestone was produced in Cherokee County, S. C., in 1965. The limestone was quarried by Campbell Limestone Company and used for flux, agricultural limestone, and fertilizer filler.

Mica

Scrap mica was produced in Stokes County, N. C., in 1961-62. Sheet mica was produced in Ashe, Rutherford, and Stokes Counties, N. C., in 1961-62 and in Greenville and Oconee Counties, S. C., in 1961. There was no production reported for the period 1963-65.

Vermiculite

A small quantity of vermiculite was produced in Spartanburg County, S. C., in 1961-62, but no production was reported for 1963-65.

Metals

Copper, gold, and silver had been recovered by Appalachian Sulphides, Inc., at their Ore Knob mine in Ashe County, N. C. In 1962, the mine was closed because of depletion of the ore bodies. There has been no production of metals in the Subregion since that time.

CONCLUSIONS

The mineral industry of Subregion D contributed about $12 million to the basic economy of the area in 1965. Minerals utilized in the construction industry comprised 94 percent of the total mineral value on an at-the-mine basis. Most of the minerals are of low unit value and are consumed close to the point of production since haulage costs are a significant economic factor.

Increased quantities of mineral construction materials will be needed for expanded construction programs; ample reserves are available in the Subregion to meet this demand.

THE MINERAL INDUSTRY OF WATER SUBREGION E

by

F. Vernon Tompkins[1/]

ABSTRACT

Water Subregion E in northern Alabama and Georgia, excluding counties in Alabama and Mississippi which were added to Appalachia (Subregion E) by amendments to the Appalachian Regional Development Act in 1967, is about one-fourth the combined area of these States. The mineral industry of Subregion E in Alabama and Georgia employed 8,514 men in 1965, and produced minerals valued at $216.8 million. The value is 57 percent of the total mineral production of the two States and 1 percent of national total mineral production. Included in the mineral yield were barite, bauxite, cement (masonry, portland, and slag), clay (fire and miscellaneous clay, and kaolin), bituminous coal, iron ore, lime, mica, natural gas, sand and gravel, crushed stone (granite, limestone, marble, sandstone, and slate), dimension stone (limestone, marble, and sandstone), and talc. Many minerals and mineral products are exported from the Subregion to the southeastern States bordering the Gulf of Mexico. A few minerals are marketed nationally. Reserves of most minerals produced in the Subregion are large. The future outlook is for increased production to supply markets of an expanding economy.

Amendments to the Appalachian Regional Development Act in 1967 designated additional counties as Appalachian. A contiguous group of counties, two in Alabama and 20 in Mississippi, were added to Subregion E. Mineral production of the additional counties is shown separately in supplemental tables.

INTRODUCTION

Subregion E, the most southerly portion of the region designated Appalachia by the Appalachian Regional Development Act of 1965, is in northern Alabama and northern Georgia and includes most of the counties north of the fall line in Alabama except those of the Tennessee River Basin (fig. E-1). The area it covers is about

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one-fourth of the area of these two States. The area is drained principally by the Alabama and Tombigbee-Warrior Rivers. The value of minerals produced in Subregion E in 1965 was 1 percent of the national production and 57 percent of the production of Alabama and Georgia.

The processing and use of minerals is concentrated near the Birmingham industrial complex in Jefferson and contiguous counties of Alabama. Minerals produced in these counties account for over three-fourths of Subregional production.

The mineral industry is important to the economy of Subregion E; it sold products valued at $216.8 million and employed 8,514 men in primary production in 1965. Of equal or greater economic importance are the mineral dependent industries which are located near local sources of raw materials. Many of the dependent industries, the processors or manufacturers, require coal, nonmetals, or iron ore for continued production and expansion.

The mineral industry of the Subregion is beneficial to the economy of the southeastern United States. Many of the mineral products are geographically the nearest, and the most competitive, source available for this regional market.

Long-range forecast is for an accelerated increase of mineral production in the Subregion. The average annual increase was 2.2 percent per year from 1952 to 1961 and 3.0 percent per year from 1961 to 1965. Percentage increase for the latter period would be greater if iron ore were not included. Additional impetus in production is expected in areas adjacent to the Alabama-Coosa River when that waterway is completed.

Additional counties were designated Appalachian by the Appalachian Regional Development Act Amendments of 1967. Two of these counties are in Alabama and 20 are in Mississippi. The addition of 22 counties to Subregion E increased the area 45 percent while the total value of mineral production of the expanded Subregion increased 3 percent.

MINERAL RESOURCES OF SUBREGION E

Mineral production in Subregion E is listed in two tables. Quantity and value of mineral production which may be published for the years, 1961 through 1965, are in table E-1. Value of mineral production and minerals produced in each county in 1965 are given in table E-2. Quantity and value for minerals not shown are withheld to avoid disclosing individual company data. Mineral production of 22 counties in Alabama and Mississippi, included in Subregion E by amendment of the Appalachian Regional Development Act in 1967, is listed in supplementary tables E-1 and E-2.

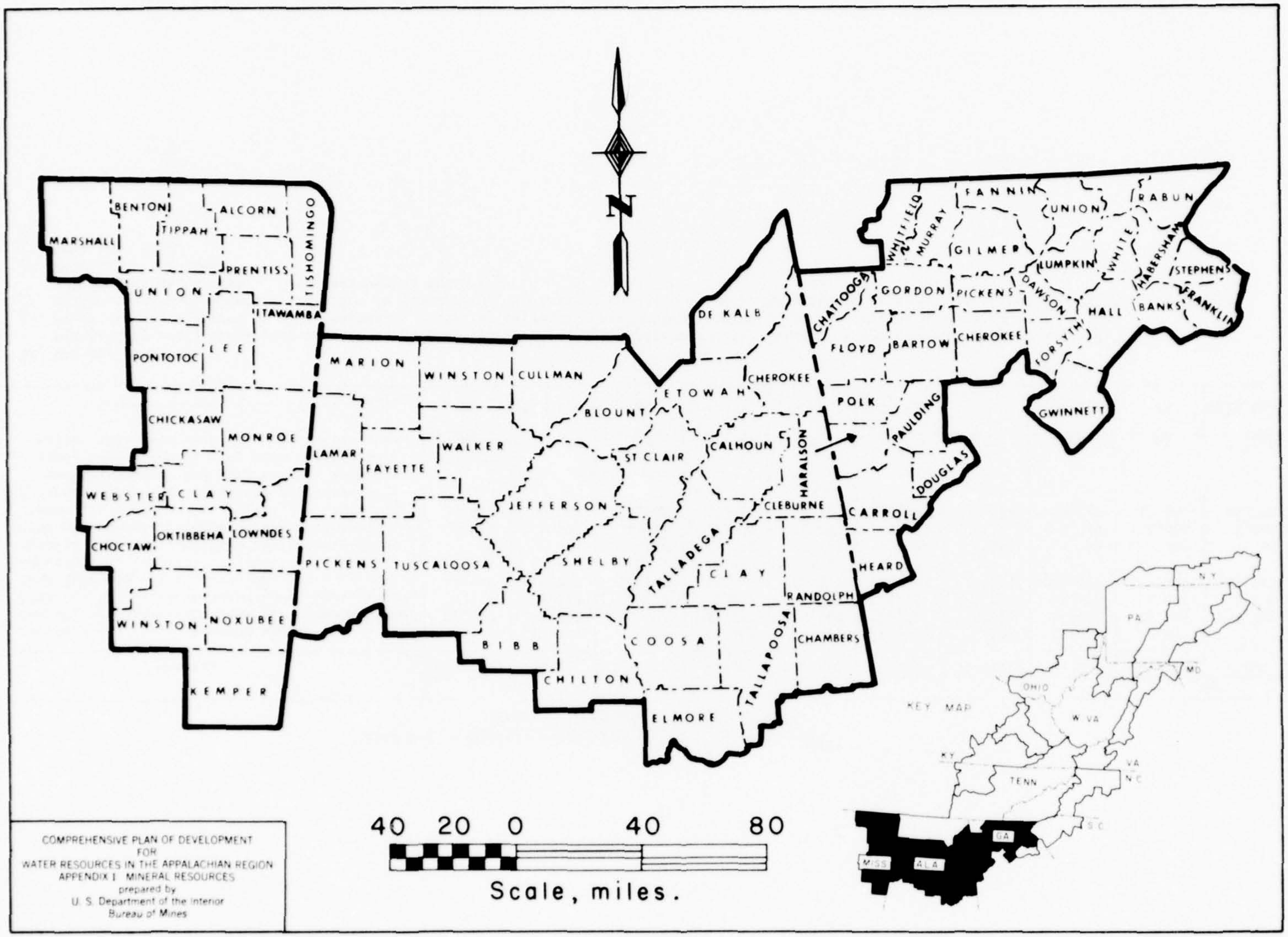

FIGURE E-1. - Water Subregion E.

TABLE E-1. - Mineral production in Water Subregion E 1/ 2/
(Value in thousand current dollars)

Mineral	1961		1962		1963		1964		1965	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Barite............thousand short tons........	107	$2,046	109	$1,987	117	$2,013	109	$2,022	W	W
Cement, portland...thousand 376 pound barrels.	10,527	33,218	10,467	33,912	10,345	32,326	10,926	34,011	11,566	$35,782
Clay..............thousand short tons........	1,176	1,549	1,072	1,457	1,047	2,511	1,293	3,530	1,684	4,538
Coal (bituminous)..........do................	12,899	90,804	12,865	95,044	12,340	91,098	14,272	101,492	14,559	105,247
Gem stones....................................	-	-	(3/)	(4/)	(3/)	2	-	-	-	-
Natural gas........million cubic feet.........	56	4	128	13	177	21	166	18	203	26
Sand and gravel....thousand short tons........	1,552	1,505	1,081	1,056	1,405	1,429	1,212	1,339	1,584	1,765
Stone.....................do................	13,063	33,086	12,568	32,866	13,335	36,502	17,786	43,010	17,414	46,281
Value of items that cannot be disclosed: *Bauxite, masonry and slag cement, iron ore,* lime, manganiferous ore, mica, talc, and values indicated by W......................	XX	31,057	XX	27,382	XX	22,631	XX	22,840	XX	23,165
Total 2/............................	XX	$193,269	XX	$193,717	XX	$188,533	XX	$208,262	XX	$216,804

XX Not applicable.
W Withheld to avoid disclosing individual company confidential data; included with "Value of items that cannot be disclosed."
1/ Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
2/ Excludes value of mineral production in Alabama and Mississippi counties added to Subregion E by amendment of the Appalachian Regional Development Act in 1967. See supplemental table E-1.
3/ Weight not recorded.
4/ Less than $500.

TABLE E-1 supplement[1/]. - Mineral production in Water Subregion E in Alabama and Mississippi[2/]
(Value in thousand current dollars)

Mineral	1961		1962		1963		1964		1965	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Clay................thousand short tons..	563	$3,351	552	$3,706	632	$3,894	700	$4,106	766	$4,757
Iron ore............thousand long tons...	-	-	-	-	-	-	-	-	W	W
Natural gas.........million cubic feet...	8,190	1,523	7,621	1,448	5,311	956	4,712	815	4,008	763
Natural gas liquid..thousand gallons.....	-	-	204	10	59	3	148	7	112	6
Petroleum...........thousand barrels.....	30	85	30	82	20	55	13	34	10	26
Sand and gravel.....thousand short tons..	1,173	930	908	754	1,207	996	1,121	1,003	1,048	921
Stone.....................do...........	W	W	W	W	-	-	-	-	W	W
Total[3/]........................	XX	$5,889	XX	$6,000	XX	$5,904	XX	$5,965	XX	$6,473

XX Not applicable.
W Withheld to avoid disclosing individual company confidential data; not included in the total.
1/ Supplement to table E-1 includes mineral production in two counties in Alabama and 20 counties in Mississippi which were added to Water Subregion E by the Appalachian Regional Development Act Amendments in 1967.
2/ Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
3/ These figures are not included in Appalachian totals.

TABLE E-2. - Value of mineral production in Water Subregion E by States and counties, 1965[1/] (excludes Mississippi counties[2/])

State and county	Value (current dollars)	Minerals produced in order of value
Alabama:		
Bibb..........	W	Coal, limestone.
Blount........	W	Iron ore, coal, cement, fire clay, limestone.
Calhoun.......	W	Fire clay, limestone, miscellaneous clay.
Cherokee......	$5,000	Sand and gravel.
Chilton.......	W	Do.
Cullman.......	31,673	Coal.
DeKalb........	W	Limestone.
Elmore........	W	Sand and gravel, miscellaneous clay.
Etowah........	W	Coal, limestone, sand and gravel, fire clay.
Fayette.......	W	Sand and gravel.
Jefferson.....	94,316,913	Coal, cement, limestone, iron ore, miscellaneous clay, sandstone, sand and gravel.
Marion........	W	Coal, kaolin, sand and gravel, natural gas.
Randolph......	W	Mica.
St. Clair.....	W	Cement, limestone, fire clay, coal, miscellaneous clay.
Shelby........	27,828,773	Lime, cement, limestone, coal, miscellaneous clay, iron ore.
Talladega.....	W	Marble, limestone, talc.
Tuscaloosa....	W	Coal, sand and gravel, iron ore.
Walker........	W	Coal, fire clay, miscellaneous clay.
Winston.......	768,635	Coal.
Georgia:		
Bartow........	4,270,766	Barite, limestone, slate, iron ore, bauxite, iron oxide pigments.
Chattooga.....	W	Marble.
Cherokee......	W	Mica, sand and gravel.
Douglas.......	W	Granite.
Floyd.........	W	Limestone, miscellaneous clay, kaolin.
Gilmer........	W	Marble.
Gordon........	17,300	Miscellaneous clay.
Gwinnett......	W	Granite.
Hall..........	W	Do.
Murray........	313,200	Talc.
Pickens.......	W	Marble, sandstone.
Polk..........	W	Cement, slate, miscellaneous clay, iron ore, sandstone.
Rabun.........	W	Granite.
Stephens......	W	Do.
Whitfield.....	W	Limestone.
Undistributed...	89,251,728	
Total.....	216,803,988	

W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."

1/ The following counties are not listed because no production was reported - Alabama: Chambers, Clay, Cleburn, Coosa, Tallapoosa; Georgia: Banks, Carroll, Dawson, Fannin, Forsyth, Franklin, Habersham, Haralson, Heard, Lumpkin, Paulding, Towns, Union, and White.

2/ See supplemental table E-2.

TABLE E-2 supplement[1]. - Value of mineral production in Water Subregion E by States and counties, 1965[2]

State and county	Value (current dollars)	Minerals produced in order of value
Alabama:		
Mississippi:		
Alcorn........	W	Clays.
Chickasaw.....	$10,328	Natural gas.
Clay..........	366,798	Natural gas, sand and gravel, petroleum, natural gas liquids.
Itawamba......	W	Clays, natural gas.
Kemper........	W	Iron ore.
Lee...........	W	Clays.
Lowndes.......	289,200	Sand and gravel, clays.
Marshall......	W	Clays.
Monroe........	2,886,503	Clays, natural gas, sand and gravel, petroleum.
Noxubee.......	W	Clays.
Pontotoc......	W	Do.
Prentiss......	7,500	Do.
Tippah........	W	Do.
Tishomingo....	W	Sand and gravel, stone.
Undistributed...	2,913,031	
Total.....	3/4/ 6,473,360	

W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."

1/ Supplement to table E-2 includes value of mineral production in two counties in Alabama and 20 counties in Mississippi which were added to Water Subregion E by the Appalachian Regional Development Act Amendments of 1967.

2/ The following counties are not listed because no production was reported - Alabama: Lamar, Pickens; Mississippi: Benton, Choctaw, Oktibbeha, Union, Webster, Winston.

3/ Iron ore and stone are not included in the total.

4/ This figure is not included in Appalachian totals.

Fuels

Bituminous Coal

Ninety eight percent of the bituminous coal produced in Alabama in 1965 was mined in Subregion E. The major part was produced in the Cahaba and Warrior coalfields, which are southeast and northwest, respectively, of Birmingham, Ala. Minor production came from the Plateau coalfield of northeastern Alabama. Coal was mined in 1965 in 11 counties from 205 mines which employed 5,093 men. The leading producing counties were Jefferson, Tuscaloosa, and Walker. The leading companies were Southeast Electric Generating Co., United States Steel Corp., Alabama By-Products Corp., and Peabody Coal Co., which together produced 48 percent of the coal in the Subregion. About two-thirds of the coal production was from underground mines and one-third was from strip mines.

Coal production increased an average of 3 percent annually from 1961 to 1965. In 1965, 14.6 million tons of coal from the Subregion valued at $105.2 million was about 3 percent of the total produced in the United States.

Coal is used extensively in the Subregion for generation of electricity, making steel and cement, and other industrial uses. It is exported from the Subregion to a regional market where it is in competition with coal that is shipped by water from other areas. A small tonnage of coal is sold locally and regionally for the domestic market.

Coal reserves[2/] are adequate for many years. The outlook is for a gradual increase in production. A long-range projection must take into consideration a combination of lower quality coal, thinner coalbeds, or deeper mines.

Natural Gas

Small quantities of natural gas are produced in Marion County, Ala. Exploration in the Subregion has found no petroleum to date.

Nonmetals

The value of nonmetal production in 1965 was $107.4 million which was 50 percent of the value of all minerals produced in Subregion E, and was over 2 percent of national total nonmetal production.

2/ Culbertson, William C. Geology and Coal Resources of the Coal-Bearing Rocks of Alabama. U.S. Geol. Survey Bull. 1182-B, 1964, p. B66.

Barite

Barite was produced in Bartow County, Ga., by four companies, which supplied 13 percent of the national barite production in 1964. The leading producer was Paga Mining Co.

A major part of the barite production is exported from the Subregion to a regional market for use as an additive in drilling mud. Some barite is marketed nationally as fillers or barium chemicals, which are compounded locally.

Reserves of barite are adequate to permit production at the current rate for many years. The outlook is for continued production in competition with barite from Tennessee, South Carolina, and other domestic and foreign sources.

Cement

The cement industry of Subregion E is concentrated in Jefferson and adjacent counties of Alabama, with four plants in Jefferson, one plant each in Blount, Shelby, and St. Clair Counties, and one producer in Polk County, Ga. Eight companies produced cement in 1965. Portland and masonry cement were produced at seven plants, and slag and masonry cement at two plants. The leading producer of all types of cement was Southern Cement Co.

The Subregion has the greatest concentration of cement-producing facilities in the Southern States. Production increased by an average of 3 percent per year from 1961 to 1965 and was nearly 4 percent of the national cement production in 1965. A large part of the cement was exported to a regional market where it was in competition with cement from Tennessee. Primary uses were buildings, highways, and other construction.

Limestone and clay, the raw materials needed for cement, occur in abundance. The outlook is for a gradual increase of cement production to supply an expanding construction industry in the Southern States.

Clay

Combined production of fire clay, miscellaneous clay,[3/] and kaolin in the Subregion was 1.5 million tons in 1965. This was 3 percent of the national clay production. Clay production increased an average of 11 percent per year from 1961 to 1965.

3/ Miscellaneous clay includes clays and shales of many types used in the manufacture of such products as brick and tile as well as cement and lightweight aggregates. The materials often consist of mixtures of several clay minerals. Products such as pottery, refractories, and fillers also may contain miscellaneous clay and shale.

Fire clay was mined in five Alabama counties by 11 producers at 14 locations in 1965. The leading producers were Donoho Clay Co. and Russell Coal and Clay Co. with mines in Calhoun and Walker Counties. Refractories (firebrick, etc.) are made from fire clay in the Subregion and sold locally and on the regional market. A small quantity of fire clay is shipped from the area and used to mix with other clay to make building bricks. Reserves of fire clay are adequate.

Miscellaneous clay was mined in six Alabama and three Georgia counties by 15 producers at 17 locations in 1965. The leading producers were Southern Cement Co., Shelby County, and Jenkins Brick Co., Elmore County, Ala. The clay was used primarily for manufacture of portland cement and building bricks. A small quantity was used for other clay products, such as tile and lightweight aggregate. Most of the clay products were marketed locally. Reserves of miscellaneous clay are extensive.

Kaolin was mined by Thomas Alabama Kaolin Co. in Marion County, Ala., and American Cyanamid Co. in Floyd County, Ga. Most of it was used as filler or coating for a variety of products (floor tile, insecticides, paper, etc.). Some kaolin was used in making firebrick and ceramics. Kaolin is exported from the area to regional and national markets.

Lime

Lime production in the Subregion increased by an average of 3 percent per year from 1961 to 1965. In 1965, five companies produced quicklime and hydrated lime in Shelby County, Ala. The leading producer was Southern Cement Co.

Lime, a product made by burning limestone, is a basic industrial chemical; it is also used for agricultural purposes and for mortar. It was sold both to local and regional markets. Reserves of limestone are plentiful.

Mica

Scrap mica production in the Subregion varied slightly from 1961 to 1965. Three companies mined scrap mica in 1965. The leading producer was U.S. Gypsum Co. in Randolph County, Ala. Two producers were in Cherokee County, Ga. Some of the scrap mica was processed locally, and part of it was sent to St. Louis, Mo., for further grinding.

Ground mica, a product of scrap mica, is used as a coating for roofing, in making plasterboard joint cement, and as a filler in paint and rubber. Ground mica is sold on a national market. Scrap mica reserves are adequate for the future.

Sand and Gravel

Sand and gravel was produced by 10 companies in eight counties in Alabama and by one company in Georgia, with total employment of 122 men. Leading producers were Alabama Gravel Co. and Wade & Vance Sand & Gravel Co. in Elmore and Chilton Counties, Ala. Sand and gravel was sold on the local market principally for use as concrete aggregate. Resources of sand and gravel are deficient in some parts of the Subregion, but crushed stone, also produced in the Subregion, is a competitive substitute.

Stone

Production of crushed and dimension stone increased an average of 8 percent per year from 1961 to 1965. Limestone, marble, granite, slate, and sandstone produced in the Subregion in 1965, and valued at more than $46 million, was 2 percent of the quantity and nearly 4 percent of the value of the national stone production. Employment in the crushed and dimension stone industry in the Subregion in 1965 was 1,395 men.

Crushed limestone was produced by 26 companies at 30 locations in 1965. Leading counties were Shelby and Jefferson in Alabama, which together produced 79 percent of the total. The leading companies were Vulcan Materials Co. and Southern Cement Co. with quarries in Shelby County, Ala. Crushed limestone is used for making cement and lime, as concrete aggregate, roadstone, railroad ballast, for agricultural purposes, as flux in making iron and steel, and in miscellaneous industrial processes. Most of the limestone is marketed locally. Limestone reserves are extensive.

Crushed marble was produced by four companies at seven locations in Pickens, Gilmer, and Chattooga Counties in Georgia and Talladega County, Ala. The leading producer was Georgia Marble Co. with mines and quarries in Georgia and Alabama. Crushed marble is used as terrazzo, roofing granules, roadstone, fillers, and extenders. It is sold on local, regional, and national markets. Reserves of marble for crushed stone are extensive.

Crushed granite was produced in the Subregion in 1965 in Georgia by six companies at seven quarries in five counties. The leading producing counties were Gwinnett and Douglas. Crushed granite is used as aggregate, roadstone, railroad ballast, and stone sand. Most of the crushed granite is sold locally, but small tonnages are marketed in Georgia outside the Subregion. Reserves of granite are extensive.

Slate is crushed or pulverized in Georgia in Bartow County by The Ruberoid Co. and in Polk County by the Georgia Lightweight Aggregate Co. Products from slate are lightweight aggregate, roofing

granules, and slate flour. Lightweight aggregates are marketed locally in competition with other materials. Slate flour, used as a filler, and roofing granules must compete in regional and national markets with other mineral products. Reserves of slate are extensive.

Crushed sandstone was quarried by four producers, three in Jefferson County, Ala., and one in Polk County, Ga. The leading producers were United States Steel Corp. in Jefferson County, and Marquette Cement Manufacturing Co. in Polk County. Most of the sandstone was used by these two companies in producing cement. A small quantity was marketed locally as refractory or foundry sand. Sandstone reserves are extensive.

Dimension stone was produced in the Subregion by four companies at five quarries in 1965. Dimension marble was produced by the Georgia Marble Co. in Pickens County, Ga., and Talladega County, Ala., and by Morretti-Harrah Marble Co. in Talladega County, Ala. Dimension limestone was quarried in Blount County, Ala., and dimension sandstone in Pickens County, Ga. These products are used for building and ornamental stone and monuments. The market for dimension marble is national; for dimension limestone and sandstone it is local. Reserves are adequate but demand for dimension stone is unpredictable.

Talc

Talc was mined in 1965 by Georgia Talc Co. in Murray County, Ga., and by American Talc Co. in Talladega County, Ala. Ground talc is used as a filler or coating for a variety of products. Dimension talc is used for electrical insulators, gas burner tips, metal workers' crayons, and chemical laboratory equipment. Talc produced in the Subregion competes with that from other localities, and with other substances used for the same purposes. Markets for talc are regional and national.

Metals

Bauxite

A small tonnage of chemical-grade bauxite is produced in Bartow County by American Cyanamid Co. The company also brings bauxite from other locations in Georgia to be dried at its plant in Bartow County.

Iron Ore

Iron ore was produced by six companies at seven mines in four Alabama and two Georgia Counties in 1965. The leading producer was Woodward Iron Co. with mines in Jefferson and Tuscaloosa Counties in Alabama. Ore was shipped to company furnaces in Jefferson County.

Iron ore from Subregion E is in competition with ore produced at other localities in Alabama and Georgia, and with foreign ore. Iron ore output in Subregion E decreased about 75 percent between 1961 and 1965 because of competition from ores imported from other regional and foreign sources. The ore is used for making pig iron and steel in the Birmingham-Gadsden area.

Reserves of low-grade iron ore are substantial but many of the higher grade, near-surface ores are depleted. The outlook is for no large increase in production if foreign sources of ore remain available.

The New Riverside Ochre Co. produced crude and finished iron oxide pigments in Bartow County, Ga., in 1965.

CONCLUSIONS

Subregion E is rich in mineral resources. In 1965, minerals produced in the Subregion were valued at 1 percent of the total of national mineral production. Of greater significance, the Subregion covers 25 percent of Alabama and Georgia but accounted for 57 percent of the value of minerals produced in these States in 1965. Mineral production in the Subregion is concentrated in Jefferson and contiguous counties in Alabama. This area accounted for three-fourths of the value of minerals produced in the Subregion in 1965.

Primary markets for minerals produced in the Subregion were local and regional; a few minerals were marketed nationally. Production and export of minerals or mineral products from the Subregion stimulates the Subregional economy as well as the economy of the area near the locality of mining, concentrating, or processing. Also of economic importance is the export of manufactured or fabricated products by mineral dependent industries which are located near local sources of raw material.

The future outlook for the mineral industry of the Subregion is for increased production to supply local, regional, and national markets of an expanding economy.

THE MINERAL INDUSTRY OF WATER SUBREGION F

by

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ABSTRACT

Water Subregion F includes 41 counties in New York, Pennsylvania, Ohio, and West Virginia, comprising the northwesternmost water subregion in Appalachia. It lies almost completely in the northern Appalachian Plateau region and is largely drained by the Ohio River and its tributaries. Its mineral resources are bituminous coal, petroleum, natural gas, sand and gravel, stone, clay, cement, lime, and salt. The total value of mineral output in 1965 was more than $750 million; 79 percent was due to bituminous coal. More than 25 percent of the Nation's bituminous coal tonnage was mined here. The area ranks second in value of mineral production among the 10 Water Subregions comprising the Appalachian Region. It is also the most populous and industrialized area of Appalachia and consumption of the mineral output of the Subregion is largely internal.

INTRODUCTION

Water Subregion F consists of 41 contiguous counties, three in southwestern New York, two in eastern Ohio, 23 in western Pennsylvania, and 13 in northern West Virginia (fig. F-1). By areas, it is 7.2 percent of New York, 2.3 percent of Ohio, 38.3 percent of Pennsylvania, and 16.2 percent of West Virginia, and totals 25,544 square miles. Drainage is predominantly by tributaries of the Ohio River, although the northern boundary counties (Erie County in Pennsylvania and Allegany, Cattaraugus, and Chautauqua Counties in New York) partially drain into Lake Erie and the Genesee River, and several of the northeastern boundary counties in Pennsylvania (Cameron, Clearfield, Elk, and Potter) drain wholly or partly into the Susquehanna River. Physiographically, the Subregion is in the Appalachian Plateau province, except that the northern parts of the two counties bordering Lake Erie are within the Central Lowlands province.

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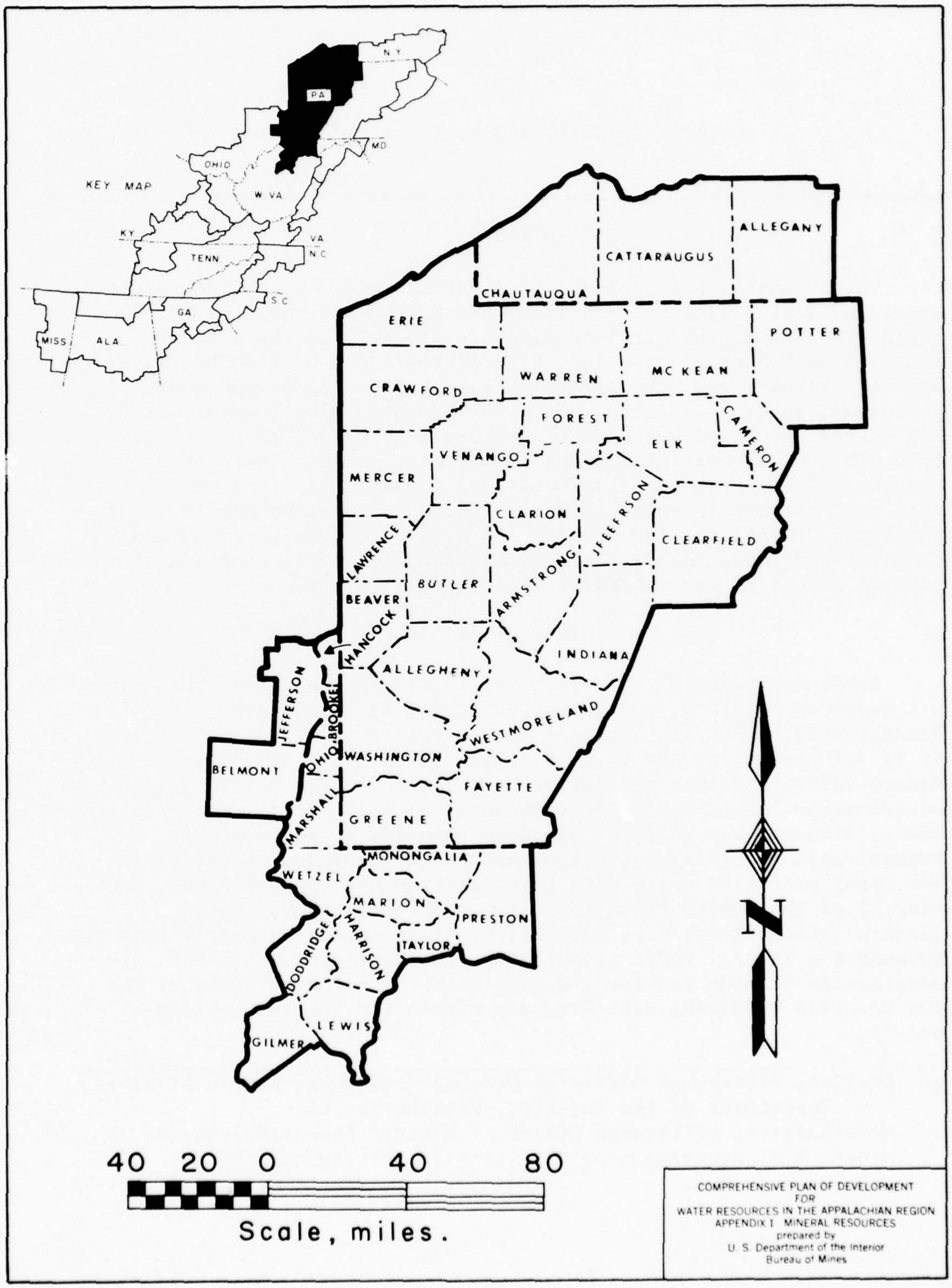

FIGURE F-1. - Water Subregion F.

Subregion F is the most heavily populated and industrialized Subregion and, consequently, has the highest total employment in the Appalachian Region. Its population in 1960 was 4.8 million, which was 2.7 percent of the United States and 27.6 percent of the Appalachian Region. Employment for the Subregion was 1.6 million or 29.4 percent of the total employment in Appalachia.

Mining, petroleum production and refining, and primary metals production are of great economic significance in the Subregion (table F-1). Employment in these industries totaled 343,737 in 1960, which was 21 percent of total employment in Subregion F, and 39 percent of employment in these industries in the entire Appalachian Region. In 1960, the Subregion accounted for 25 percent of the Appalachian Region employment in both mining and construction, 51 percent in petroleum production, and 63 percent in primary metals.

The mineral industry is an important source of income for Subregion F. In 1965, the value of mineral production in the Subregion was $787.9 million (1958 constant dollars), which was 28 percent of the total for the Appalachian Region, and the second highest among the 10 Subregions (table F-2). The apparent paradox of second place in mineral value produced and first place in employment is explained by the heavy concentration of primary metals production in Subregion F; the metals are produced from ores mined outside the Subregion. The value of mineral production averaged $157.82 (1958 constant dollars) per capita in 1965.

Mineral production was reported in all of the 41 counties in Subregion F in 1965. Table F-3 presents the value by counties where such data may be disclosed.

MINERAL RESOURCES OF SUBREGION F

Fuels

Bituminous Coal

In 1965 bituminous coal was mined in 31 of the 41 counties of Subregion F, and outputs of more than 1 million tons were reported from mines in 21 counties. Mining was carried on at 94 mines in both counties of the Ohio segment of the Subregion, at 855 mines in 18 of the 23 counties in the Pennsylvania segment, and at 314 mines in 11 of the 13 counties in the West Virginia segment. No coal occurs in the three New York counties; they are north of the bituminous coal fields. Of the Subregion's bituminous coal output in 1965, 10 percent was produced in Ohio, 55 percent in Pennsylvania, and 35 percent in West Virginia. Deep-mined coal accounted for nearly 75 percent of the output in 1965, and strip-mined coal accounted for the bulk of the remainder; only a comparatively small tonnage of auger-mined coal was produced.

TABLE F-1. - Employment in mineral-related industries, total employment and population, Water Subregion F, 1940-2000 1/

Years	Mineral-related industries: Mining	Construction	Petroleum	Primary metals	Total employment	Total population
	Employment and Population					
1940	130,220	51,521	-	-	1,506,175	4,361,315
1950	121,414	87,777	13,332	212,021	1,630,404	4,558,969
1960	51,610	82,638	5,219	204,270	1,609,581	4,771,011
1980	33,794	106,495	3,690	201,868	1,951,396	5,656,317
2000	27,031	129,876	2,142	180,790	2,314,519	6,644,993
	Distribution of Employment (percent)					
1940	8.6	3.4	-	-	-	-
1950	7.4	5.4	.8	13.0	-	-
1960	3.2	5.1	.3	12.7	-	-
1980	1.7	5.5	.2	10.3	-	-
2000	1.2	5.6	.1	7.8	-	-
	Change in Employment					
1940-1960	-78,610	+31,117	+5,219	+204,270	+103,406	-
1960-1980	-17,816	+23,857	-1,529	-2,402	+341,815	-
1980-2000	-6,763	+23,381	-1,548	-21,078	+363,123	-
	Relative Change in Employment (percent)					
1940-1960	-60.4	+60.4	(2/)	(2/)	+6.9	-
1960-1980	-34.5	+28.9	-29.3	-1.2	+21.2	-
1980-2000	-20.0	+22.0	-42.0	-10.4	+18.6	-

1/ Population and employment data from Office of Business Economics, Department of Commerce.
2/ Indeterminate.

TABLE F-2. - Mineral production and value in Water Subregion F, 1961-65

Mineral	1961	1962	1963	1964	1965
Production:					
Cement:					
Portland and Masonry.thousand 376-lb. bbl.	8,100	8,142	8,429	9,477	11,140
Clays..................thousand short tons..	2,003	1,860	2,122	2,222	2,325
Coal (Bituminous).............do...........	91,385	95,713	103,792	114,130	119,853
Natural gas...........million cubic feet...	173,405	164,524	162,631	144,877	144,932
Natural gas liquids 1/..thousand gallons.....	127,030	131,459	122,774	110,896	104,861
Peat..................short tons...........	W	W	12,272	13,067	12,891
Petroleum.............thousand 42-gal. bbl.	8,655	9,263	9,227	8,309	8,505
Sand and gravel........thousand short tons..	7,887	9,350	9,246	10,466	11,665
Stone.......................do...........	6,503	7,734	7,555	8,175	9,321
Value, thousand 1958 constant dollars:					
Cement:					
Portland and Masonry.....................	27,156	26,577	27,391	30,869	35,409
Clays....................................	12,485	10,760	11,831	12,365	13,693
Coal (Bituminous)........................	475,259	500,595	536,819	595,616	624,667
Natural gas..............................	49,454	44,391	42,311	38,332	36,763
Natural gas liquids 1/......................	6,979	6,793	6,370	5,499	4,907
Peat.....................................	(2/)	(2/)	85	101	110
Petroleum................................	39,878	40,394	40,218	35,401	35,538
Sand and gravel..........................	11,026	12,949	13,550	14,554	16,137
Stone....................................	11,354	13,465	13,519	13,352	15,935
Items that cannot be disclosed:					
Iron ore (pigment material, 1963-65), lime, and salt...........................	3,416	4,061	3,682	3,965	4,745
Total..............................	637,007	659,985	695,776	750,054	787,904

W Withheld to avoid disclosing individual company confidential data.
1/ Includes LP gases and natural gasoline and cycle products.
2/ Included with value of "Items that cannot be disclosed."

TABLE F-3. - Value of mineral production in Water Subregion F, by States and counties, 1965

State and county	Value in current dollars	Minerals produced in 1965 in order of value[1]
New York:		
Allegany.......	W	Sand and gravel.
Cattaraugus....	$735,000	Sand and gravel, peat.
Chautauqua.....	96,000	Sand and gravel.
Ohio:		
Belmont........	31,405,605	Bituminous coal, stone.
Jefferson......	W	Bituminous coal, clay.
Pennsylvania:		
Allegheny......	W	Bituminous coal, cement, clay, sand and gravel, stone, iron ore (pigment material).
Armstrong......	22,687,658	Bituminous coal, clay, sand and gravel, stone, lime.
Beaver.........	4,449,172	Sand and gravel, bituminous coal, clay.
Butler.........	W	Bituminous coal, cement, stone, lime, sand and gravel.
Cameron........	W	Bituminous coal.
Clarion........	12,993,341	Bituminous coal, stone, sand and gravel, clay.
Clearfield.....	29,679,981	Bituminous coal, clay, sand and gravel, stone.
Crawford.......	308,000	Sand and gravel.
Elk............	W	Bituminous coal, stone.
Erie...........	W	Sand and gravel, peat.
Fayette........	10,640,146	Bituminous coal, clay, stone, sand and gravel.
Forest.........	W	Sand and gravel.
Greene.........	W	Bituminous coal, clay.
Indiana........	W	Do.
Jefferson......	8,400,759	Bituminous coal, clay, stone.
Lawrence.......	W	Cement, stone, bituminous coal, clay, sand and gravel, peat.
McKean.........	392,657	Clay, stone, bituminous coal, sand and gravel.
Mercer.........	W	Bituminous coal, sand and gravel, stone.
Potter.........	W	Stone.
Venango........	W	Bituminous coal, sand and gravel.
Warren.........	470,000	Sand and gravel.
Washington.....	W	Bituminous coal, stone.
Westmoreland...	W	Bituminous coal, sand and gravel, stone, lime.

TABLE F-3. - Value of mineral production in Water Subregion F, by States and counties, 1965 (continued)

State and county	Value in current dollars	Minerals produced in 1965 in order of value 1/
West Virginia:		
Brooke.........	W	Bituminous coal, sand and gravel.
Doddridge......	$8,212	Stone.
Gilmer.........	W	Bituminous coal, stone.
Hancock........	W	Clay, sand and gravel, bituminous coal.
Harrison.......	W	Bituminous coal, stone.
Lewis..........	W	Bituminous coal, stone, clay.
Marion.........	72,030,408	Bituminous coal.
Marshall.......	14,137,037	Bituminous coal, salt.
Monongalia.....	W	Bituminous coal, stone.
Ohio...........	W	Bituminous coal, sand and gravel.
Preston........	W	Bituminous coal, stone.
Taylor.........	W	Bituminous coal, clay.
Wetzel.........	W	Sand and gravel.
Undistributed....	527,490,314	
Total.......	735,924,290	

W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."

1/ Natural gas, natural gas liquids and petroleum are not listed by counties as data are not available, included with "Undistributed."

In 1965, Subregion F produced 120 million tons of bituminous coal valued at $625 million (1958 constant dollars); this amounted to 24 percent of the tonnage and 26 percent of the value of the United States production. The average 1965 value per ton for bituminous coal mined in Subregion F was $4.70 (current dollars). The corresponding average value per ton for deep-mined coal was $5.20, strip-mined $3.60, and auger-mined $3.50. Production and value were second only to Subregion G. As shown in table F-2, coal production and value in Subregion F have been trending upward from 1961 to 1965; this trend is likely to continue as the demand for electric power increases. The growth of 31 percent of bituminous coal production within Subregion F in 4 years has paralleled similar growth in the other Appalachian Subregions, and Subregion F's share of production and value has remained essentially constant at one-third of the Region's total.

The most important use for bituminous coal in Subregion F was for electric energy generation, which consumed about 60 percent of the output in 1965. Other industrial applications accounted for about 26 percent; coke and gas generation for about 10 percent; and the remainder was for overseas export.

Bituminous coal production will remain an important source of value in the economy of Subregion F. Demands by thermal electric generating plants, and for metallurgical coal by the iron and steel producers in the Upper Ohio River Valley will insure a large and continuing market in the Subregion. New developments that reduce the expense of energy transportation are a great influence on the growth of bituminous coal mining in Subregion F. Unit-train operations are widely used. Mine-mouth generating plants, five large plants, are under construction or have been recently placed on-line in Subregion F.

Long-term contracts and commitments for new thermal electric generating plants indicate that coal will be the principal fuel for this purpose in the Subregion to the year 2000. However, nuclear energy for electric power generation emerged recently as a strong competitor for this market. The demand for coking coal as the principal fuel in metallurgical applications probably will remain near the present level.

Bituminous coal has remained competitive because of intensive mechanization and resultant increased productivity. Employment in coal mining will continue to decrease for the near future because the employment added by opening new and highly mechanized mines will be more than offset by the employment losses incurred when older and less efficient mines are closed.

Bituminous coal contributed 79 percent of the total mineral value reported from Subregion F in 1965, while petroleum, natural gas, and natural gas liquids together accounted for another 10 percent.

Bituminous coal reserves of Subregion F are ample for the foreseeable future.

For the longer term ahead it is now possible to predict the possibility of markets emerging for bituminous coal in conversion processes for gaseous and liquid fuels, and coal-derived chemicals. The recent acquisitions of coal producers by broad-based energy and mining companies no doubt are indicative of the market potentials for bituminous coal for conversion.

The outlook for the bituminous coal industry in Subregion F is a blend of bright and darkened prospects. Continued growth is hoped for as the conventional coal-steam-electric power market expands, with enhancement provided by mine-mouth generating plants to extend the marketing radius of coal-derived electric power. An added market would be synthetic fuels through existing coal-conversion processes. On the other side, nuclear-electric energy is coal's growing competition. It may well be that nuclear energy will fuel more than one-quarter of the Nation's new generating capacity in 1970, and that by 1972 nuclear capacity will be approximately 20 percent of the total generating capacity of 1966 (in 1966 it was barely 1 percent).

It appears that while coal production will probably increase, it is equally probable that employment in bituminous coal mining will continue its decline.

Petroleum, Natural Gas, and Natural Gas Liquids

The modern petroleum industry had its beginnings a little over a century ago, in Subregion F. Petroleum and natural gas have been produced ever since. Over the years the lands of Subregion F have been drilled extensively, first for oil, and in the past three decades additional emphasis has been placed on natural gas. One result of these efforts has been that the potential for additional recovery by shallow drilling is now considered to be limited. Natural gas is widely distributed but most recovery is from low-production wells. Occurrences of petroleum are more localized; most production is from shallow wells in the northern Pennsylvania and the New York counties of the Subregion. Present production of petroleum originates to a large extent from stripper wells which produce less than a barrel of oil per day. In response to secondary recovery measures, principally waterflooding, production is slightly improved. Petroleum and gas production in Subregion F has passed its peak. The present oil producers are, for the most part, independent operators.

Natural gas liquids are produced in Subregion F from oil refining operations, natural gas processing plants, and gas compressor stations. This class of hydrocarbons includes condensate from natural gas, liquefied petroleum gas, natural gasoline, and cycle products.

Although the production of the fluid (liquid and gaseous) hydrocarbon fuels-petroleum, natural gas, and natural gas liquids--has been in decline for many years in Subregion F, it remains, nonetheless, a sizable industry in dollar volume. In 1965, the value of fluid hydrocarbon fuels produced in Subregion F was $78 million (1958 constant dollars), or equivalent to 10 percent of the total mineral value produced in Subregion F (table F-2), and about 40 percent of the total value of fluid hydrocarbons produced in the entire Appalachian Region. In 1965, the petroleum produced in Subregion F was valued at $35.5 million, 56 percent of the Appalachian Region total for petroleum; natural gas at $36.8 million was 40 percent of the Region, and natural gas liquids at $4.9 million accounted for 18 percent.

Although the production and value of fluid hydrocarbons in Subregion F is a very small proportion of the national total, it is nonetheless an important mineral industry in the Subregion. The fluid hydrocarbon group of minerals stands in second place behind bituminous coal (table F-2) and in 1965 was about twice as large as the next largest category, cement.

Pennsylvania grade crude oil produced in Subregion F is known for its superior lubricating characteristics, and the industry is important to the Subregion.

For the future, the reserves of petroleum and natural gas indicate production for about 20 years at the present rate. The possibilities of discovering oil and gas in deeper strata are being considered. However, the employment in petroleum is too small to have much bearing on the future of Subregion F. In 1960, petroleum accounted for only 0.6 percent of the total employment in Subregion F. In the towns where refineries are located, petroleum is an important industry.

The problem facing the petroleum and natural gas industry in Subregion F is that of continually higher operating expense to achieve production from old, exhausted oil- and gasfields. The record of 1961-65 provides a clue to the outlook. During that period the production of natural gas in Subregion F declined 15 percent, natural gas liquids 20 percent, and petroleum held constant, all in a time span when the energy market for liquid hydrocarbons was growing about 15 percent. Prospects are for continued decline unless some external factor arises in petroleum and natural gas supply which leads to additional deep-drilling exploration programs in Subregion F. Office of Business Economics employment projections also indicate a continuing decline in petroleum (table F-1), from 5,219 in 1960, to 3,619 in 1980, and 2,142 in 2000.

Nonmetals

Subregion F resources of stone, mainly limestone, sandstone (including quartzite), and clay and shale are adequate, particularly in the central parts of the Subregion. Sand and gravel deposits are adequately distributed geographically throughout the area; over one-half of the 41 counties in the Subregion reported production in 1965. Salines, mainly rock salt deposits, occur throughout the Subregion but production of salt is presently confined to Marshall County, W. Va.

Construction Minerals

Stone

Stone production reported in Water Subregion F is either sandstone (including quartzite) or limestone, with the latter predominating. Much of the total stone output is crushed for use as construction aggregate (concrete aggregate and roadstone). Crushed limestone has additional application in cement and lime manufacture, and for agricultural and miscellaneous uses. A minor use for sandstone is as the dimensioned product. Stone was produced in all 10 Subregions in Appalachia in 1965 and Subregion F ranked fifth in both production and value; stone output and value show an increasing trend (table F-2). From 1961 to 1965, stone production and value in the Subregion accounted for 9 percent of Appalachia's total stone output and value.

While stone was produced in 1965 at 68 operations in the Ohio, Pennsylvania, and West Virginia segments, almost 90 percent of the Subregion's output was produced at 31 operations in six counties. These counties, each of which reported outputs in excess of 500,000 tons, were in decreasing order of production: Lawrence, Pa.; Butler, Pa.; Monongalia, W. Va.; Fayette, Pa.; Westmoreland, Pa.; and Clarion, Pa. Of the 9.3 million tons produced in 1965, about one-fourth was limestone and cement rock consumed in the Subregion's cement plants. Although limestone is the most important stone mined or quarried in Subregion F, its occurrence is mainly confined to the central portion of the Subregion in the thin limestones of Pennsylvanian age. Reserves in terms of quantity are adequate for present and anticipated future needs, and the quality is satisfactory for construction uses and for use in cement manufacture. These deposits, however, are not generally acceptable for the more compositionally demanding chemical uses such as metallurgical fluxstone and chemical lime manufacture. Fluxstone and chemical lime consequently are largely imported from outside the Subregion. Sandstones are widely distributed, and reserves are adequate for any foreseeable demands of the construction industry.

The outlook for the Subregion's stone industry is favorable. Demand by cement manufacture, of which the Subregion is the second largest Appalachian producer, and by the construction industry will

continue strong. Projections for construction employment (table F-1) presage an increase paralleling the growth of population through the year 2000. The consumption of stone in construction will probably increase at a faster rate than the construction employment data indicate, since improvements in construction technology will continue to increase the consumption of construction materials per unit of manpower. Also, reserves of naturally occurring gravel are limited, and depletion of this aggregate source will be countered by increased production of crushed stone for coarse construction aggregate.

Sand and Gravel

The output of sand and gravel in 1965 was the largest in tonnage and the second largest in value among all Subregions. Sand and gravel is produced both by conventional open pit mining and by dredging the Ohio River and its tributaries. Demand is mainly by the construction industry, the largest in Appalachia, for building, paving, railroad ballast, fill, and miscellaneous uses. A limited tonnage of industrial quality sand is also marketed. The value contributed by sand and gravel production in Subregion F has been steadily increasing during the 1961-65 interval (table F-2). From 1961 to 1965, the Subregion has accounted for an average of 33 percent of the output and an average of 29 percent of the value for all sand and gravel produced in Appalachia.

Sand and gravel output was 11.7 million tons in 1965 from 69 operations in 23 counties. The Pennsylvania segment led in production with 47 operations in 16 counties and accounted for 8 million tons, or over two-thirds of the total output. The New York and the West Virginia segments had 15 operations (three counties) and seven operations (four counties), respectively. Four counties, Beaver, Erie, and Westmoreland Counties, Pa., and Hancock County, W. Va., reported outputs in excess of 1 million tons in 1965. Four counties, Armstrong and Mercer Counties, Pa., Cattaraugus County, N. Y., and Ohio County, W. Va., each produced between 500,000 and 1 million tons.

The outlook for sand and gravel is good and consumption will parallel the projected increase in construction employment through the year 2000 (table F-1). While sand is in adequate supply throughout the Subregion, the reserves of gravel are limited. However, any deficiencies in the areal supply of natural gravel could be met within the area by the substitution of crushed stone; near the iron and steel producing areas, by crushed blast furnace slag, of which the Subregion's blast furnaces produced nearly 6 million tons in 1965.

Cement

Subregion F is the second largest source of cement in the Appalachian Region with five plants in three counties; Allegheny, Butler, and Lawrence in Pennsylvania. Both portland and masonry cement were

produced in all three counties, with sales of portland cement accounting for over 90 percent of the combined value in 1965. The combined production of portland and masonry cement has shown a consistently increasing trend from 1961 to 1965 (table F-2). In the 1961-65 period, Subregion F accounted for 22 percent of the output and 23 percent of the value of the cement produced in the Region.

Portland cement was produced in two plants near Pittsburgh, Allegheny County; one plant near West Winfield, Butler County; and at two plants in Lawrence County, one near Bessemer and another near Wampum. In 1965, shipments of portland and masonry cements were 10.4 million 376-pound barrels and 1 million 280-pound barrels, respectively. Of the portland cement shipments, 62 percent were made to ready-mixed concrete companies, 16 percent to highway and other contractors, 14 percent to concrete product manufacturers, and the remaining 8 percent to other users. Of the shipments, 54 percent were to western Pennsylvania, 37 percent to Ohio, 8 percent to West Virginia, and the remaining 1 percent to other States.

Substantial quantities of lime-bearing materials--mainly locally produced limestone, cement rock, and blast furnace slag--were consumed in the manufacture of portland cement, along with sizable quantities of shale and sand. In 1965, more than 2 million tons of low magnesian limestone or equivalent calcium bearing rock and over 150,000 tons of clay or shale were consumed in local cement production.

The outlook for cement manufacture in Subregion F is favorable, at least 5 percent of the portland cement manufacturing capacity of the Eastern United States is provided by the five plants in the Subregion. A predominant share of the cement produced in the Subregion, estimated to exceed two-thirds of production, is also consumed therein by the areal construction industry. This substantial internal market is aided by terms of the Appalachian Development Act, which favors concrete for highway construction.

Clay and Shale

Clay and shale deposits, mainly in the central portion of Subregion F, ranked second in output and first in value among the 10 Subregions in Appalachia. Clay was produced in all the Subregions in 1965. The output was predominantly used in the manufacture of refractory (fire clay) and building brick. The Pennsylvania segment of Subregion F led in production with 82 operations in 11 centrally located counties. The Ohio segment had four operations in one county, while the West Virginia segment had three operations in three counties. No clay production was reported from the New York segment. Seventy-two operations in eight counties accounted for 90 percent of the Subregion's clay output in 1965. All eight counties produced in excess of 100,000 tons and, in decreasing order of output, were Lawrence, Clearfield, Armstrong, and Jefferson Counties, Pa.; Hancock County, W. Va.; Fayette County, Pa.;

Jefferson County, Ohio; and Beaver County, Pa. Clay production and value have shown a moderately increasing trend since 1962 (table F-2).

During the period 1961-65, the Subregion's share of Appalachian clay was 26 percent of the output and 47 percent of the value. The disparity between percentages of output and value is due to the higher value of that portion of the clay (about 25 percent of the Subregion's production) used in refractory applications.

The markets for clay and shale will depend on future demand by users of refractory brick and by brick and tile use in the construction industries in the Subregion. While the greater value of clay production is primarily due to that portion used in refractory manufacture (fire clay), the changing technology in steelmaking, with increasing emphasis toward basic refractory brick, will result in a lesser demand for fire clay. Also, the Subregion's economically minable deposits of high-grade fire clay, historically important, are now nearing depletion. The higher tonnage, but lower valued clays (including shale) are used in construction applications as building brick, tile, and other heavy clay products. While the demand for clay products will parallel the growth of the construction industry in the Subregion, competition from other structural materials will be a depressing factor.

The overall outlook for clay is a diminishing market for refractory use (fire clay) and an increased demand for clay and shale as construction materials, but at a slower growth rate than the economy in general.

Outlook for Construction Minerals

In 1965, Subregion F produced slightly over 23 million tons of construction materials, including clay, sand and gravel, and stone, but excluding cement, and accounted for about 16 percent of the total Appalachian output of 142 million tons. On a per capita basis the total production was comparatively low - less than two-thirds the Appalachian average and slightly over one-half the National average (table F-4). The Subregion's population, however, is the largest of the 10 Subregions in Appalachia and in 1965 accounted for about 27 percent of the entire Region.

TABLE F-4. - Per capita production of construction minerals, 1965, short tons[1/]

Mineral	United States	Appalachian Region	Subregion F
Stone..................	3.5	4.7	1.5
Sand and gravel........	4.7	1.8	2.4
Clay and shale.........	.2	.2	.4
Total............	8.4	6.7	4.3

1/ Excluding minerals consumed in cement production.

However, if the effect of the almost 6 million tons of blast furnace slag, which was produced in the Subregion, is taken into account, the per capita production is greater. Assuming that the slag produced was consumed as construction aggregate supplementing sand and gravel and stone, this would be an additional 1.2 tons per capita, thus raising the total per capita production of construction minerals to 5.5 tons. With this assumption, the total production on a per capita basis would be over four-fifths the Appalachian average and about two-thirds the national average.

The outlook for construction minerals should be good. Projections by the Office of Business Economics (OBE) indicate a growth rate of 0.8 percent from the 1960 census of the 4,771,001 population in 1960 to the OBE projection of 5,656,317 in 1980. The percent of employment in the construction sector in Subregion F is projected to increase from 5.1 percent in 1960 to 5.5 percent in 1980. From 1960 to 1980, the OBE forecasts indicate that about 25 percent of all employment in the construction sector in Appalachia will be in Subregion F.

The total value of stone, sand and gravel, and clay and shale in Subregion F in 1965 was $45.8 million (1958 constant dollars), 17 percent of Appalachia, and $9.17 per capita. As with all low-cost bulk materials, the transportation costs determine the market radius. Consequently, areas in which mineral production is greatest are those closest to consuming markets; Subregion F, the most industrialized area in Appalachia, essentially consumes its own output of construction minerals. The resources of stone, sand and gravel, and clay and shale are adequate to support any foreseeable demand to the year 2000. Then too, blast furnace slag, which can substitute for or augment stone or sand and gravel as a construction aggregate, is produced in large quantity, almost 6 million tons in 1965.

Minor Nonmetal Commodities

Water Subregion F is also a source of several other nonmetals.

Salines

Subregion F has extensive reserves of salines (mainly rock salt) throughout the area, but salt is produced in only one area bordering the Ohio River. Two firms (Pittsburgh Plate Glass Co. and Solvay Process Division, Allied Chemical Corp.) produce brine by solution mining of rock salt deposits in Marshall County, W. Va. Both companies manufacture chlorine and caustic soda by electrolysis of the brine.

Peat

Peat for agricultural use was produced in 1965 at one operation each in Cattaraugus County, N. Y., and Erie County, Pa., and two operations in Lawrence County, Pa. The 1965 output of 13,000 short tons was valued at $115,000.

Iron Ore

Crude red iron oxide pigments are produced as a coproduct of alumina recovered from bauxite (not mined in Subregion F) by one firm in Allegheny County, Pa.

Lime

In 1965, lime production was reported from three operations, one each in Armstrong, Butler, and Westmoreland Counties, Pa. It was marketed mainly as agricultural lime; a limited quantity was produced for use as fluxing lime. Production and value data are withheld to avoid disclosing individual company confidential data. Lime production in Subregion F will remain limited mainly because of the compositional quality of the original limestone.

Metals

No production of metals from ores mined in Subregion F was reported in 1965. However, the importance of metal production in the Subregion from ores or concentrates produced in other areas can hardly be overstated. Primary metal production, of which the making and fabrication of iron and steel is predominant, is the most important single industry in Subregion F. In 1960, the number employed in the primary metal sector was 204,270, or 12.7 percent of total employment, and 62.5 percent of the total Appalachian employment. The iron and steel plants in the Subregion, in addition to their importance in providing jobs, are also important consumers of minerals (and their derived products) as well as the basic raw material (iron ore). In 1965, an estimated 13.6 million tons of coke were consumed, equivalent to about 20.3 million tons of bituminous coal, chiefly by the Subregion's blast furnaces. An estimated 6 million tons of fluxing material, primarily limestone (high-calcium and dolomitic) but also including lime, were consumed by the iron and steel industry. Subregion F supplies most of the bituminous coal for coke, but most of the fluxing material is imported from other areas. Almost 18 million tons of pig iron, slightly over one-fifth of the total tonnage produced in the United States in 1965, was made by the blast furnaces of iron and steel plants located along the upper Ohio River and its tributaries in the Subregion. Almost 6 million tons of blast furnace slag were produced as a byproduct of pig iron manufacture. Crushed or granulated slag is competitive with crushed stone and sand and gravel as a construction

aggregate. Of the 16 iron and steel plants, 13 were in the Pennsylvania segment of Subregion F -- eight in Allegheny County, two in Westmoreland County, and one each in Beaver, Erie, and Mercer Counties. There were also two plants in Jefferson County, Ohio, and one in Hancock County, W. Va.

While the primary metals sector of employment in Subregion F represented 12.7 percent of the Subregion's total in 1960, the trend is a declining one. As shown in table F-1, the projection is for employment in primary metals to decrease 1.2 percent, from 204,270 workers in 1960 to 201,868 in 1980. This projection may be conservatively high. Trends to larger scale units and technological improvements tend to accelerate the decline in employment.

CONCLUSIONS

Of the 10 Water Subregions that comprise the Appalachian Region, Subregion F is by far the most affluent in terms of per capita wealth, industrial development, urbanization, total employment, and population. Because of the greater degree of industrialization, it differs uniquely from the rest of Appalachia, in that its industrial complex is an important importer of minerals, as well as a significant exporter of mineral derived products.

The iron and steel industry in 1965 consumed in the area's blast furnaces an estimated 31 million tons of both domestic and foreign iron ore. A significant tonnage of coke, in addition to that produced from its own coal, and an appreciable quantity of Appalachian-produced fluxstone was used.

However, in common with the other Appalachian areas, the Subregion's economy is narrowly based. It is too restricted to mining and metal production, for which OBE projections presage substantial declines in employment in the period to the year 2000. The obvious, but difficult, solution to unemployment resulting from technological advances and increased productivity per unit of manpower in mining and metal production is to provide diversification by encouraging other employment-generating industries whose activities do not parallel mining and metal production.

THE MINERAL INDUSTRY OF WATER SUBREGION G

by

R. G. Clarke[1/]

ABSTRACT

The total value of minerals produced in 1965 was $875 million (current dollars), over 80 percent from bituminous coal. Much of the bituminous coal production is shipped out of the Subregion to manufacturing centers bordering Appalachia and Subregion G to the east, north, and west. Production of petroleum, natural gas, natural gas liquids, stone, sand and gravel, and cement in addition to bituminous coal comprise significant portions of production and value. Mining employment for 1960 to 1980 is projected to decrease by 41 percent but employment in related industries will increase 35 percent which will balance the mining decrease numerically.

INTRODUCTION

Subregion G consists of 13 counties of northeastern Kentucky, 26 counties of southeastern Ohio, eight counties of southwestern Virginia, and 34 counties of West Virginia. By area it is 11.8 percent of Kentucky, 31.1 percent of Ohio, 7.1 percent of Virginia, and 69.1 percent of West Virginia and totals 36,891 square miles. With the exception of Smyth County, Va., in the Tennessee River Basin, all of these counties are in the Ohio River Basin.

Physiographically, 85 percent of Subregion G is in the Appalachian Plateaus province; the remaining area in the Subregion includes a portion of the Blue Ridge province (Carroll, Floyd, and Grayson Counties, Va.), the Valley and Ridge province (Bland, Giles, Pulaski, Smyth, and Wythe Counties, Va., and portions of Greenbrier, Monroe, Pocahontas, Randolph, and Tucker Counties, W. Va.), the Central Lowlands (Lewis County, Ky., and Brown, Clermont, Highland, and Ross Counties, Ohio). Figure G-1 shows the Subregion and its location within the Appalachian Region.

In 1960, the population of Subregion G was 2,783,231, which is 1.58 percent of the United States population and 16 percent of the Appalachian Region population (table G-1). Total employment in Subregion G in 1960 was 784,964; of which 8.6 percent was in mining,

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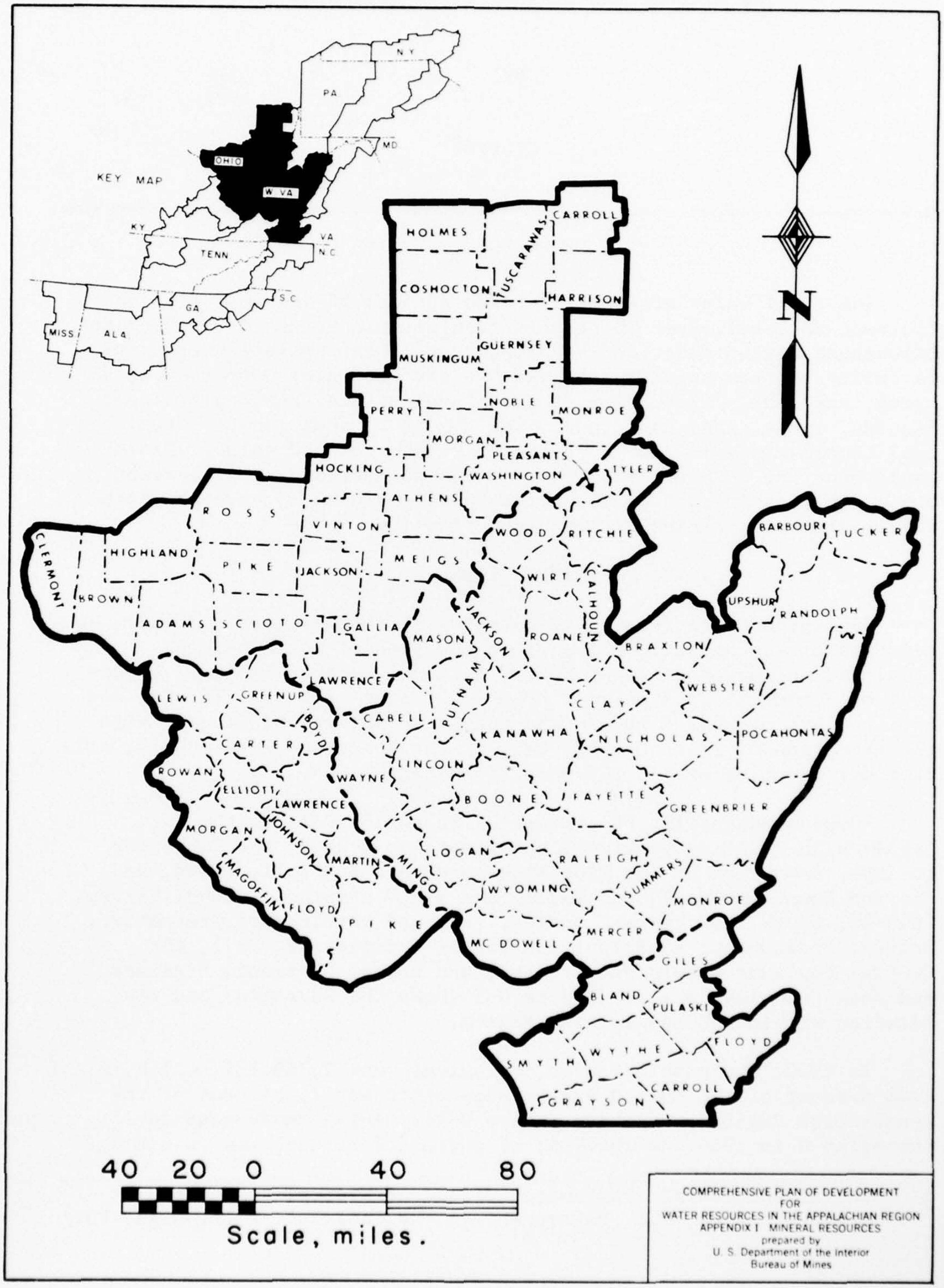

FIGURE G-1. - Water Subregion G.

as compared with 3.8 percent for the Appalachian Region, and 1 percent for the United States. In that year, 18.8 percent of employment in Subregion G was in mineral-related industries (table G-1) compared with 16.1 percent in the Appalachian Region. Thus, the economy of Subregion G is slightly more dependent on the mineral-related industries than the Region as a whole.

Production and value of minerals in Water Subregion G exceeded those of all other Subregions in the most recent 5-year period (table G-2). In 1965, total value of minerals produced was $938 million (1958 constant dollars); 34 percent of the total for Appalachia. The value of bituminous coal production was 83 percent and petroleum, natural gas, and natural gas liquids was 9 percent. Mineral production was reported from 70 counties (table G-3). Values of more than $1 million (current dollars) each were reported from 31 counties. The largest county value, $108 million, was reported from McDowell County, W. Va.

MINERAL RESOURCES OF SUBREGION G

Fuels

Bituminous Coal

The coal resources of Subregion G are probably greater than in any other area of comparable size in the world. From 1961 to 1965, both output and value of bituminous coal increased by almost one-third (table G-2); in 1965 Subregion G led all the Water Subregions in the Appalachian Region, accounting for 41 percent of the Region's output of bituminous coal.

In 1965, 50 of the 81 counties in Subregion G reported coal production. Kentucky had 874 operating mines in 10 counties; 80 percent of the output was from underground mining and 10 percent each from strip and auger mining. Ohio had 250 mines in 18 counties; strip mining provided the major share of the output, 65 percent, underground mining, 30 percent, and auger mining, 5 percent. West Virginia had 1,310 mines in 22 counties; 90 percent of the production is by underground mining, 7 percent from strip mining, and 3 percent from auger mining. Strip and auger mining are progressively becoming more important because of lower production costs. The growth in coal production has brought an increase in the number of large mines. The average Appalachian Region coal mine produced about 56,000 tons per year. The mines in Ohio produced an average of 110,000 tons per year and West Virginia mines averaged 90,000 tons per year. In contrast, the average mine in Kentucky produced 24,000 tons per year. Probably two-thirds of the mines of 500,000 tons or more capacity per year in the Appalachian Region are in Subregion G. The value of bituminous coal per ton ranges from about $3 to over $5.50. The higher values are placed on coking coal for metallurgical purposes, and on low-sulfur coal (less than 1 percent sulfur). Low-sulfur coal commands a

TABLE G-1. - Employment in mineral-related industries, total employment and population, Water Subregion G, 1940-2000[1/]

Years	Mineral-related industries				Total employment	Total population
	Mining	Construction	Petroleum	Primary metals		
Employment and Population						
1940	123,638	30,372	-	-	730,466	2,729,277
1950	148,470	46,263	2,854	22,554	871,943	2,847,878
1960	67,316	46,487	2,517	31,572	784,964	2,783,231
1980	39,769	58,789	2,418	47,493	967,089	3,266,528
2000	30,148	76,754	2,610	60,690	1,240,107	3,977,866
Distribution of Employment (percent)						
1940	16.9	4.2	-	-	-	-
1950	17.0	5.3	0.3	2.6	-	-
1960	8.6	5.9	.3	4.0	-	-
1980	4.1	6.1	.3	4.9	-	-
2000	2.4	6.2	.2	4.9	-	-
Change in Employment						
1940-1960	-56,322	+16,115	(2/)	(2/)	+54,498	-
1960-1980	-27,547	+12,302	-99	+15,921	+182,125	-
1980-2000	-9,621	+17,965	+192	+13,197	+273,018	-
Relative Change in Employment (percent)						
1940-1960	-45.6	+53.1	(2/)	(2/)	+7.5	-
1960-1980	-40.9	+26.5	-3.9	+50.4	+23.2	-
1980-2000	-24.2	+30.6	+7.9	+27.8	+28.2	-

1/ Population and employment data from Office of Business Economics, Department of Commerce.
2/ Indeterminate.

TABLE G-2. - Mineral production and value in Water Subregion G, 1961-65

Mineral	1961	1962	1963	1964	1965
Production:					
Cement:					
Portland and masonry.thousand 376-lb. bbl.	4,118	4,249	4,260	4,300	4,572
Clays..................thousand short tons..	2,368	2,147	2,131	2,119	2,380
Coal (bituminous).............do...........	114,926	122,981	139,292	143,750	150,994
Gem stones................................	NA	NA	NA	-	-
Lime..................thousand short tons..	531	475	479	579	635
Natural gas...........million cubic feet...	193,224	190,616	192,687	191,283	198,465
Natural gas liquids[1/]..thousand gallons.....	517,412	486,878	472,254	475,669	490,044
Petroleum (crude)......thousand 42-gal. bbl.	5,456	5,191	5,177	6,812	5,874
Sand and gravel........thousand short tons..	5,981	6,249	6,759	6,062	7,632
Stone........................do...........	9,204	9,851	11,030	11,467	12,213
Lead (recoverable content of ores, etc.) ....short tons..........	3,733	4,059	3,500	3,857	3,651
Zinc (recoverable content of ores, etc.) ....short tons..........	22,586	20,214	20,864	21,004	20,491
Value, thousand 1958 constant dollars:					
Cement:					
Portland and masonry.....................	14,035	14,002	14,297	14,093	14,980
Clays....................................	8,124	6,798	7,195	6,753	7,943
Coal (bituminous).........................	586,409	624,646	710,884	739,878	773,875
Gem stones................................	(2/)	(2/)	(2/)	-	-
Lime......................................	5,418	5,487	5,631	6,710	7,449
Natural gas...............................	51,502	50,510	49,414	47,432	46,551
Natural gas liquids[1/]......................	26,874	23,282	22,032	22,662	23,089
Petroleum (crude).........................	18,201	16,706	16,555	21,968	18,684
Sand and gravel...........................	8,686	9,634	9,911	9,580	11,549
Stone.....................................	17,542	18,182	20,358	21,209	23,093
Lead......................................	680	655	657	810	837
Zinc......................................	4,610	4,119	4,349	4,567	4,366
Items that cannot be disclosed: Abrasives, bromine (1961), calcium-magnesium chloride, gypsum (1965), ilmenite (1961, 1962), iron oxide pigments, and salt..........................	4,880	5,137	4,200	4,189	5,821
Total..............................	746,961	779,158	865,483	899,851	938,237

NA Not available.
1/ Includes LP gases and natural gasoline and cycle products.
2/ Less than $500.

TABLE G-3. - Value of mineral production in Water Subregion G, by States and counties, 1965

State and county	Value in current dollars	Minerals produced in 1965 in order of value[1/][2/]
Kentucky:		
Boyd..........	$195,544	Bituminous coal, miscellaneous clay, petroleum.
Carter........	1,367,955	Fire clay, limestone, bituminous coal.
Elliott.......	195,504	Petroleum, bituminous coal.
Floyd.........	26,209,557	Bituminous coal, petroleum.
Greenup.......	322,990	Fire clay, petroleum.
Johnson.......	2,162,910	Petroleum, bituminous coal.
Lawrence......	1,506,336	Do.
Lewis.........	-	-
Magoffin......	2,299,863	Petroleum, bituminous coal.
Martin........	1,374,632	Bituminous coal, petroleum, sand and gravel.
Morgan........	853,408	Limestone, bituminous coal, petroleum.
Pike..........	W	Bituminous coal, petroleum, limestone, sand and gravel.
Rowan.........	468,380	Fire clay, limestone, miscellaneous clay.
Ohio:		
Adams.........	1,266,766	Stone.
Athens........	1,365,302	Bituminous coal, stone, clay, sand and gravel.
Brown.........	102,900	Stone, sand and gravel.
Carroll.......	1,063,779	Bituminous coal, clay, sand and gravel, stone.
Clermont......	-	-
Coshocton.....	12,164,347	Bituminous coal, sand and gravel, stone.
Gallia........	2,233,239	Bituminous coal, stone, sand and gravel, clay.
Guernsey......	1,144,195	Bituminous coal.
Harrison......	34,709,562	Bituminous coal, stone, clay.
Highland......	W	Stone, sand and gravel, clay.
Hocking.......	469,605	Bituminous coal, clay.
Holmes........	1,439,756	Bituminous coal, stone, clay, sand and gravel.
Jackson.......	3,673,708	Bituminous coal, clay, stone, sand and gravel.
Lawrence......	10,850,028	Cement, stone, bituminous coal, clay, sand and gravel.
Meigs.........	W	Sand and gravel, bituminous coal, salt, stone.
Monroe........	W	Sand and gravel, stone.

TABLE G-3. - Value of mineral production in Water Subregion G, by States and counties, 1965 (continued)

State and county	Value in current dollars	Minerals produced in 1965 in order of value1/2/
Ohio - Continued		
Morgan........	W	Bituminous coal, sand and gravel, stone.
Muskingum.....	W	Cement, stone, sand and gravel, bituminous coal, clay.
Noble.........	W	Bituminous coal, stone, clay.
Perry.........	W	Bituminous coal, sand and gravel, clay, stone.
Pike..........	W	Sand and gravel, stone.
Ross..........	W	Do.
Scioto........	W	Stone, sand and gravel, clay.
Tuscarawas....	$14,252,457	Bituminous coal, clay, sand and gravel, stone.
Vinton........	637,915	Bituminous coal, stone.
Washington....	W	Sand and gravel, bituminous coal, abrasives.
Virginia:		
Bland.........	18,772	Stone.
Carroll.......	-	-
Floyd.........	19,700	Stone.
Giles.........	W	Lime, stone.
Grayson.......	152,148	Stone.
Pulaski.......	W	Stone, iron ore (pigment material).
Smyth.........	W	Lime, salt, stone, gypsum, sand and gravel, clay.
Wythe.........	8,359,077	Zinc, stone, lead, sand and gravel.
West Virginia:		
Barbour.......	14,328,035	Bituminous coal.
Boone.........	38,329,519	Do.
Braxton.......	W	Stone, bituminous coal.
Cabell........	W	Sand and gravel, clay.
Calhoun.......	-	-
Clay..........	257,764	Bituminous coal.
Fayette.......	27,771,017	Do.
Greenbrier....	6,755,949	Bituminous coal, stone.
Jackson.......	-	-
Kanawha.......	46,892,306	Bituminous coal, salt, clay, stone, calcium-magnesium chloride.
Lincoln.......	W	Bituminous coal, sand and gravel.
Logan.........	74,313,414	Bituminous coal.
Mason.........	1,490,919	Bituminous coal, sand and gravel.
McDowell......	107,807,209	Bituminous coal, stone.
Mercer........	8,217,633	Bituminous coal, stone, clay.

TABLE G-3. - Value of mineral production in Water Subregion G, by States and counties, 1965 (continued)

State and county	Value in current dollars	Minerals produced in 1965 in order of value 1/ 2/
West Virginia - Continued		
Mingo.........	$29,312,840	Bituminous coal.
Monroe........	-	-
Nicholas......	38,133,070	Bituminous coal, stone.
Pleasants.....	W	Salt, sand and gravel.
Pocahontas....	514,070	Bituminous coal, stone.
Putnam........	-	-
Raleigh.......	W	Bituminous coal, stone, sand and gravel.
Randolph......	W	Bituminous coal, stone.
Ritchie.......	-	-
Roane.........	-	-
Summers.......	-	-
Tucker........	W	Bituminous coal, stone.
Tyler.........	W	Sand and gravel.
Upshur........	W	Bituminous coal, stone.
Wayne.........	W	Bituminous coal.
Webster.......	3,096,846	Do.
Wirt..........	-	-
Wood..........	W	Sand and gravel.
Wyoming.......	76,039,395	Bituminous coal, stone, sand and gravel.
Undistributed...	270,865,322	
Total......	875,005,643	

W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."

1/ Natural gas and natural gas liquids are not listed by counties as data are not available, included with "Undistributed."

2/ Petroleum values are listed by county in Kentucky; data are not available by county in Ohio, Virginia, and West Virginia, included with "Undistributed."

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DEVELOPMENT OF WATER RESOURCES IN APPALACHIA. VOLUME 24. APPEND--ETC(U)

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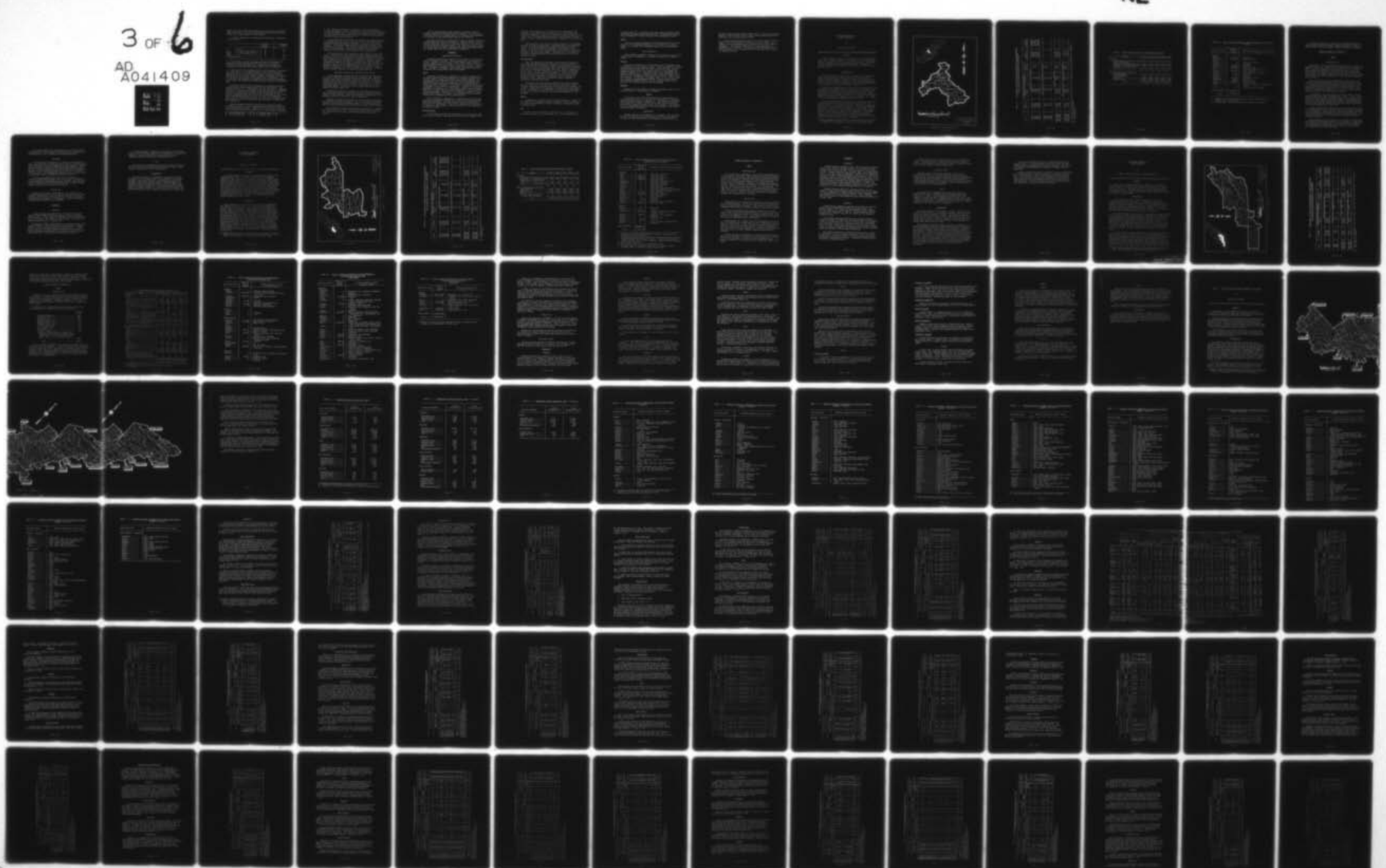

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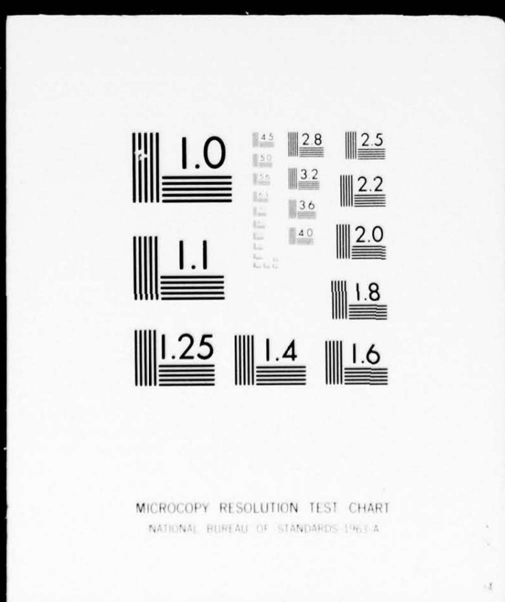

higher price for electric generating use in areas where air pollution must be minimized. Low-sulfur coal production and reserves are the subject of a current Bureau of Mines project.

In 1965, consumption of bituminous coal and lignite, in percent, was as follows:

	United States	Subregion G
Electric utilities	49	36
Coke [illegible]s for iron blast furnaces	20	22
Cement, [illegible]l, and rolling mills	4	-
Other	20	28
Overseas exports	7	14

It is significant that the percentage exported from Subregion G is double the national average, and that the portion for electric utilities is almost one-third less. Reserves are estimated to be sufficient for over 400 years at the current rate of production.

Other fuels for the expanding electric energy market are becoming more competitive. It is expected that by 1972, nuclear electric generating facilities will have increased in the area surrounding Appalachia and in the Region itself. However, bituminous coal remains the prime fuel for electric utility generation in Subregion G. As of late 1967, announcements of expansion in the States of Subregion G were entirely for conventional thermal plants, all fueled by bituminous coal.

Long-term contracts between bituminous coal operators and their customers assure stable future markets for the coal industry. The Central Ohio Coal Co., a subsidiary of the Ohio Power Co., is expending $40 million on its captive Muskingum strip mine estimated to increase output by 1.8 million tons per year. This installation will use specially designed hopper cars and electric locomotives for the 15-mile haul to the generating plant.2/ Over a 12-year period beginning April 1968, the Island Creek Coal Co. will ship 5 to 10 million tons of metallurgical coal to the Netherlands from its mines in Virginia and West Virginia.3/

Other developments helping to maintain the competitive status of bituminous coal for electric energy generation are unit-trains and mine-mouth generating plants. Because of the short haul for fuel, 10 electric generating plants have been built or are proposed in Subregion

2/ Mining Engineering. V. 19, No. 11, November 1967, p. 29.
3/ Mining Engineering. V. 19, No. 11, November 1967, p. 27.

G. The competitive distance for shipment of coal from Subregion G has been increased by the use of unit-trains, which have been effective in reducing freight rates. Unit-trains are complete trains of assigned cars and locomotives operating on regularly scheduled cycles between specified origins and destinations.

The technological improvements in production and consumption which have caused bituminous coal to continue to be the principal source of mining employment and wealth in Subregion G have also caused other problems. Technological improvements have resulted in greater coal production by fewer men. Some land use problems are created by deep, strip, and auger mining. Mining creates stream and water-supply problems with pollution by silt and acid water in some areas.

Coal markets other than for electric power generation will grow slowly. The quantity of coke needed to produce a given quantity of pig iron from ore is being reduced by improved metallurgical procedures even though the rate of production is increasing. Sales of coal for cement production are influenced by the price of competitive fuels. Overseas coal exports are subject to international trade problems. An additional use for coal is being tested in a pilot plant for coal-to-gasoline conversion by a private contractor to the Office of Coal Research at Cresap, W. Va. The last application opens up a potential field of organic chemicals now enjoyed by petrochemicals.

Petroleum, Natural Gas, and Natural Gas Liquids

In the Appalachian Plateaus province, petroleum and natural gas are found in generally the same areas as bituminous coal. Most oil production has come from shallow fields which have been extensively drilled; the wells are normally low capacity producers. In 1961-65, crude petroleum production in Subregion G ranged from 5 to 7 million barrels per year; this was about one-third the production of the Appalachian Region. The value of the oil ranged from $16 million to almost $22 million (table G-1).

Natural gas production increased from 193 billion cubic feet in 1961 to 198 billion cubic feet in 1965; the value decreased from $51 million to $46.5 million. Production and value of natural gas in the Subregion is about 50 percent of that in Appalachia.

Subregion G accounts for 80 percent of the production and value of natural gas liquids in Appalachia. Natural gas liquids production decreased from 517 million gallons in 1961 to 490 million gallons in 1965; the value decreased from $26.8 million in 1961 to $23.1 million.

The fluid mineral fuels are significant contributors to Subregion G's mineral wealth. In 1965, of the total mineral value, petroleum was 2 percent; natural gas, 5 percent; and natural gas liquids, 3 percent.

Much of the petroleum is now produced by secondary recovery methods, usually water flooding and gas pressuring. In spite of the occasional discovery of new gas pools, it is expected that production will decrease as petroleum and gas reserves are exhausted.

Opportunities exist for discoveries of new oil and gas reserves at greater depths than those now productive. Deeper drilling in areas of current production, and also in areas where neither oil nor gas have yet been found, may increase reserves. The unexplored strata in which oil and gas might be found are geologically older and probably deeper than strata which have been productive in Subregion G.

Nonmetals

Construction Materials

Construction materials accounted for 6.9 percent of the mineral value of Subregion G in 1965. They are significant contributors, as a group, amounting to $65 million in 1965 (1958 constant dollars). Stone contributed about 2.5 percent of the value; cement, 1.6 percent; sand and gravel, 1.2 percent; clays, 0.8 percent; and lime, 0.8 percent. The market for highway and building construction materials fluctuates with construction activity and demand.

Stone

Limestone, dolomite, and sandstone are produced in Subregion G. The major product is crushed limestone for concrete aggregate, lime, fluxing, cement, highway construction, agricultural purposes, and miscellaneous uses. Dolomitic rocks are used interchangeably with limestone if the chemistry is unimportant to the end-use and are usually reported as limestone. The reserves of limestone and dolomite in Subregion G are virtually inexhaustible. Sandstone is crushed for aggregate and roadstone, or, if of suitable quality, used for dimension stone. A minor use for dimension sandstone is the manufacture of natural grindstones. Subregion G is an important producer of stone products accounting for 12 percent of the production and 13 percent of the value in Appalachia in the period 1961-65.

Stone production is widespread. In 1965 Kentucky had the least output of the Subregion with only four counties reporting production from eight operations. Virginia had seven counties reporting production from 15 operations. Twenty-three operations were reported in 12 counties in West Virginia. Fifty-two operations were reported in 22 counties in Ohio.

Sand and Gravel

Of the primary materials for construction, sand and gravel rank next to stone in value. Sand and gravel deposits are abundant in the

northern part of Subregion G, and less so in the remainder of the Subregion. High-silica sands and quartzite are used in glass and refractory manufacture. Most of the high-silica sand is mined in Perry County, Ohio. The widespread occurrence of sand and gravel in Subregion G causes a highly competitive market, especially in the northern part.

Over 90 percent of the output of sand and gravel is for building purposes and highway construction. Operations range from small bank-run pits to large operations with automated washing and screening plants. In the period 1961-65, Subregion G contributed, on the average, 21 percent of both quantity and value of the sand and gravel produced in the Appalachian Region. The opportunity to increase the production of sand and gravel will depend on the growth of the construction industry.

Clay and Shale

Clays are widespread in Subregion G and production ranks third after stone and sand and gravel. Production of clay and shale is mostly from Ohio in the Tuscarawas Valley, Hocking Valley, and Scioto Valley, and is used principally for heavy clay products and firebrick. Fire clay is produced in Big Sandy Valley, Ky., which is adjacent to Scioto Valley. In 1965, production of clay and shale in Tuscarawas County, Ohio, was the greatest in Subregion G. Thirty-three operations reported production of 931,000 tons valued at $2.6 million. Resources of clays and shales in Subregion G can be measured in billions of tons. Subregion G accounts for about 27 percent of Appalachian production and value.

The value of the clay and shale depends on the quality and end-use. Clay and shale for refractories and some face brick usually command a higher price than does the clay and shale used for heavy clay products. Shale used as an ingredient in cement may be valued much lower. The outlook for clay and shale will depend upon future demand by users of refractory brick and by construction industries in the Subregion.

Cement

In Subregion G, only Ohio reported cement production. Output was from Lawrence and Muskingum Counties. Individual county production and value data are withheld to avoid disclosure of individual company confidential data.

Lime

In 1965, lime was produced in Subregion G by Foote Mineral Co. and National Gypsum Co. in Giles County, Va., and Olin Mathieson Co.

in Smyth County, Va. Production, from these captive limestone mines, was mainly for chemical and industrial uses. Production and value of lime in Subregion G is about 25 percent of the Appalachian total.

Gypsum

Gypsum is of minor importance in both quantity and value in Subregion G. The underground operation by U.S. Gypsum Co. in Smyth County, Va., accounts for all gypsum production in the Appalachian Region.

Minor Nonmetals

Minor nonmetal commodities account for 0.5 percent or less of the mineral values of Subregion G. Reserves are ample for the markets served.

Salines

Resources of salines in the northeastern part of Subregion G may be measured in tens of millions of tons. Salt is recovered by solution mining because the salt beds are 3,000 to 7,000 feet deep. Salt is produced in Meigs County, Ohio; Smyth County, Va.; and Kanawha and Pleasant Counties, W. Va. Practically all of the output goes into chemical manufacturing. Production of salt brine is dependent on the market for the principal finished chemicals (chlorine, caustic soda, and soda ash). In addition, in Kanawha County, W. Va., brine is used for producing calcium-magnesium chloride. There have been periods when ethylene dibromide, bromine and other bromide products were produced, but currently none of these is produced.

Pigments

Natural iron oxide pigment is produced in Pulaski County, Va., by Hercules Powder Co. Data may not be published.

Metals

Zinc-lead ores are mined and concentrated in Wythe County, Va., by the New Jersey Zinc Co. Lead and zinc concentrates are shipped to separate smelters outside of Subregion G. Zinc production decreased from 22,600 tons in 1961 to 20,500 tons in 1965, but the value has declined only slightly because of unit value increases. The Subregion G share of Appalachian production and value declined in this period from 22 percent to 14 percent.

CONCLUSIONS

Abundant deposits of bituminous coal, limestone, clay and shale, salines, sand and gravel, and natural gas are found in Subregion G. The value of mineral production in the Subregion accounts for 34.2

percent of the total for the Appalachian Region. The value in current dollars in 1965 was $875 million. Based on an estimated population of 2,894,560, the per capita share was $302.

A United States population growth rate of 1.6 percent per year to 1980 is forecast by the Office of Business Economics (OBE). This compares to a corresponding population growth rate of 0.8 percent for Subregion G. The forecast growth rate for total employment in Subregion G is 1.1 percent. In contrast, mining employment, principally bituminous coal, is expected by OBE to decrease at the rate of 2.6 percent per year.

THE MINERAL INDUSTRY OF
WATER SUBREGION H

by

Vernal A. Danielson[1/]

ABSTRACT

Value of mineral production in Subregion H in 1965 was $80 million. Of the total, 78 percent was bituminous coal. Natural gas, petroleum, limestone, and clays made up the remainder. Bituminous coal was produced in the eastern counties only. The western counties produced small quantities of limestone, petroleum, natural gas, and clays.

INTRODUCTION

Water Subregion H consists of the counties of Bath, Breathitt, Clark, Estill, Fleming, Garrard, Knott, Lee, Leslie, Letcher, Lincoln, Madison, Menifee, Montgomery, Owsley, Perry, Powell, and Wolfe, in eastern Kentucky. Figure H-1 shows the Subregion and its location within the Appalachian Region. Subregion H includes parts of the Kentucky, Licking, and Cumberland River Basins.

Employment in mineral-related industries, total employment, and population in 1940, 1950, 1960, and projections to 2000 are listed in table H-1. Table H-2 shows the quantity and value of mineral production in the Subregion, by commodities, for 1961-65. Bituminous coal was 76.1 percent; petroleum 11.6 percent; natural gas 8.6 percent; and construction minerals, clay and limestone, 3.7 percent of the total Subregional mineral production in 1965.

The mineral industry is largely in the eastern part of the Subregion and primarily consists of bituminous coal mining. The mineral industry of the western section is limited to crushed limestone and a small production of crude oil. In the eastern section, the mining of coal is of prime importance to the economy. Table H-3 gives an indication of the relative importance of the mineral industry in the various counties of the Subregion. It shows the total value of mineral production by county and the minerals produced in order of value in 1965, insofar as possible since some operators request that their data be concealed.

1/ Mining engineer, Knoxville Office of Mineral Resources, Bureau of Mines, U.S. Department of the Interior, Knoxville, Tenn.

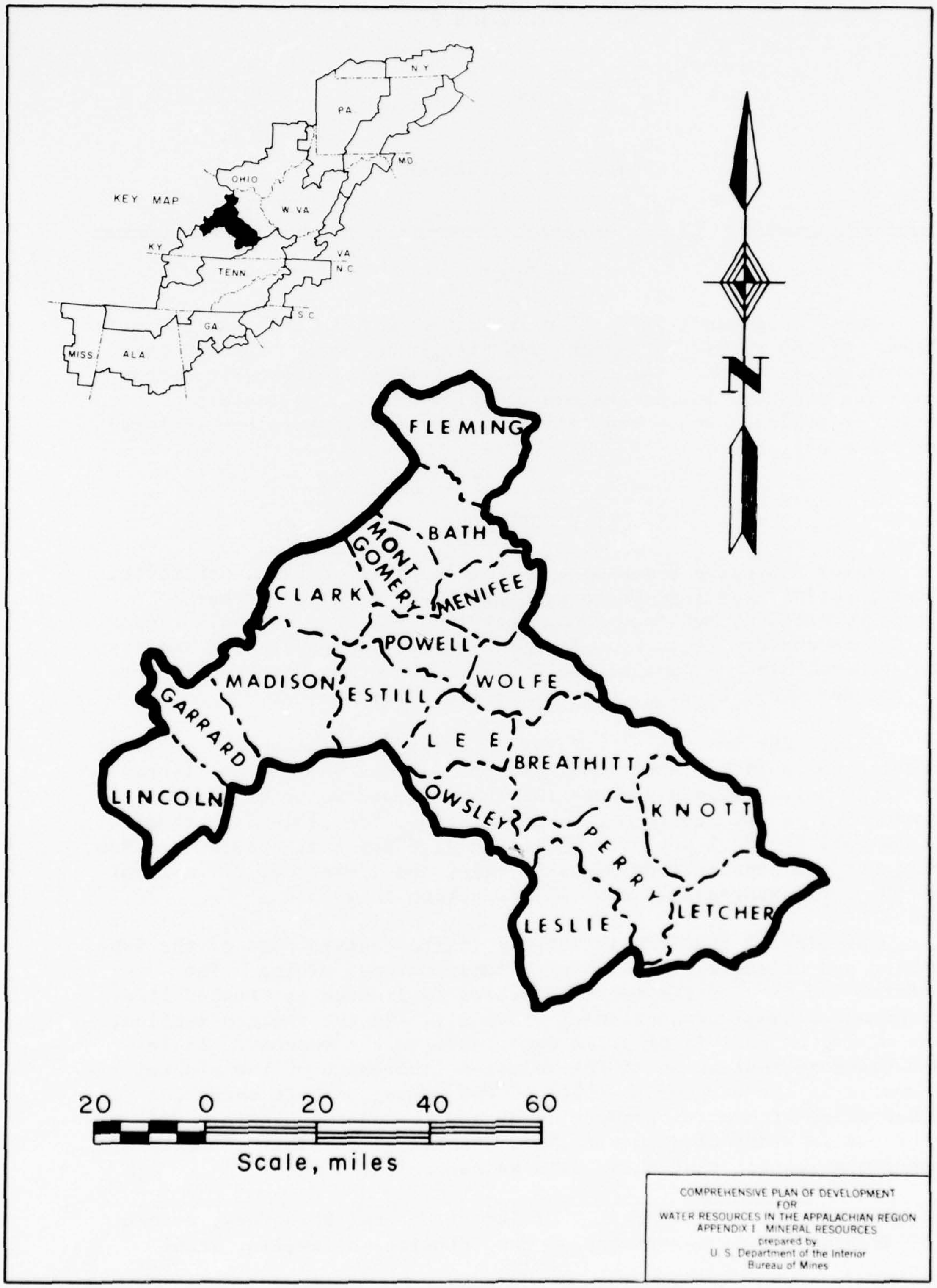

FIGURE H-1. - Water Subregion H.

TABLE H-1. - Employment in mineral-related industries, total employment and population, Water Subregion H, 1940-2000 1/

Years	Mineral-related industries				Total employment	Total population
	Mining	Construction	Petroleum	Primary metals		
Employment and Population						
1940	11,576	2,292	-	-	78,788	323,864
1950	15,607	3,855	12	35	84,681	307,045
1960	8,044	4,446	251	308	67,230	265,867
1980	6,626	6,026	440	-	78,932	291,700
2000	7,088	8,330	440	-	106,554	372,465
Distribution of Employment (percent)						
1940	14.7	2.9	-	-	-	-
1950	18.4	4.6	(2/)	(2/)	-	-
1960	12.0	6.6	0.4	0.5	-	-
1980	8.4	7.6	0.6	-	-	-
2000	6.7	7.8	0.4	-	-	-
Change in Employment						
1940-1960	-3,532	+2,154	(3/)	(3/)	-11,558	-
1960-1980	-1,418	+1,580	+189	-308	+11,702	-
1980-2000	+462	+2,304	0	-	+27,622	-
Relative Change in Employment (percent)						
1940-1960	-30.5	+94.0	(3/)	(3/)	-14.7	-
1960-1980	-17.6	+35.5	+75.3	-100.0	+17.4	-
1980-2000	+7.0	+38.2	0	-	+35.0	-

1/ Population and employment data from Office of Business Economics, Department of Commerce.
2/ Less than 0.1 percent.
3/ Indeterminate.

TABLE H-2. - Mineral production and value in Water Subregion H, 1961-65

Mineral	1961	1962	1963	1964	1965
Production:					
Coal (Bituminous).thousand short tons.	12,340	12,977	13,973	13,722	14,449
Construction Minerals:					
Clays and stone.thousand short tons.	1,531	3,170	2,273	2,143	1,748
Natural gas.......million cubic feet..	27,880	27,280	27,480	27,000	27,400
Petroleum (crude).thousand 42-gal. barrels............................	2,155	2,337	2,426	2,981	3,050
Value, thousand constant 1958 dollars:					
Coal (Bituminous)....................	59,159	61,852	62,570	55,057	62,533
Construction Minerals:					
Clays and stone....................	1,930	4,860	3,316	3,218	2,729
Natural gas..........................	6,900	6,679	6,503	6,405	6,447
Petroleum (crude)....................	6,386	6,803	7,013	8,713	8,727
Total..................	74,375	80,194	79,402	73,393	80,436

TABLE H-3. - Value of mineral production in Water Subregion H, by counties 1965

State and county	Value in current dollars	Minerals produced in 1965 in order of value
Kentucky:		
Bath...........	$12,099	Petroleum.
Breathitt......	1,566,176	Coal, petroleum.
Clark..........	-	-
Estill.........	W	Petroleum, limestone.
Fleming........	W	Limestone.
Garrard........	149,200	Limestone.
Knott..........	7,488,187	Coal, petroleum.
Lee............	W	Petroleum, limestone, coal.
Leslie.........	7,785,939	Coal, petroleum.
Letcher........	W	Coal, limestone, petroleum.
Lincoln........	12,432	Petroleum.
Madison........	W	Limestone.
Menifee........	142,363	Limestone, petroleum.
Montgomery.....	91,460	Limestone.
Owsley.........	13,352	Coal, petroleum.
Perry..........	16,370,062	Coal, petroleum.
Powell.........	W	Petroleum, limestone, miscellaneous clay.
Wolfe..........	W	Petroleum, coal, limestone.
Undistributed 1/..	41,505,912	-
Total.....	75,137,182	

W Withheld to avoid disclosing individual company confidential data; included with "Undistributed".

1/ Includes value of natural gas and values indicated by symbol W.

The mineral industry is a market for appreciable quantities of timber, steel, petroleum products, rubber, and plastics. Most of such materials, except for timber, originate outside the Subregion.

MINERAL RESOURCES OF SUBREGION H

Fuels

Bituminous Coal

Bituminous coal was produced from the eight eastern counties of Breathitt, Knott, Lee, Leslie, Letcher, Owsley, Perry, and Wolfe, in 1965. The total production was 14.4 million tons, or 31 percent of the east Kentucky production. Production from Lee, Owsley, and Wolfe Counties was about 0.2 percent; Letcher County, 40 percent; Perry County, 27.1 percent; Knott County, 16.4 percent; Leslie County, 12.9 percent; and Breathitt County, 3.3 percent of the Subregional total in 1965.

Small underground mines are predominant in Subregion H; the terrain is not generally suited to large-scale strip-mining. Many of the deposits are of limited extent, but well exposed to the outcrop, lending themselves to exploitation by small operators, who gain access to the coal either by adit, or inclined shaft. Auger mining is becoming more prevalent in the area. It is an efficient method of mining in the existing type of terrain.

In Subregion H, 518 coal mines were active in 1965, of which 464 were underground mines, 40 auger, and 14 strip. As for size of operation, there were four underground mines, but no strip or auger mines in the plus 500,000 tons per year class; 27 underground, nine strip and 15 auger mines in the plus 50,000 to minus 500,000 tons per year class; and 433 underground, five strip, and 25 auger mines in the minus 50,000 tons per year class.

Trucks are utilized at almost all of the coal mines in the area for transportation of coal. Only 14 mines, most of which are large, are rail-connected. Breathitt, Perry, Knott, and Letcher Counties have railroad facilities operating to the north and northwest. Much of the coal production of those counties is marketed by rail for manufacturing uses.

When compared with the other major coal regions, the Subregion is unfavorably situated with respect to some markets. In some cases, the coal must pass through other coal areas to reach its markets. This disadvantage is compounded by the scarcity of deposits which are suitable for low-cost strip mining.

The former domestic and railroad markets for coal have virtually disappeared. Such markets have been partially replaced by the increased use of coal in electric power generating plants.

Petroleum

Crude petroleum was produced in 13 counties of Subregion H in 1965. Lee County was the leading producer, with 2.6 million barrels, or 85.4 percent of the total production from the Subregion. Powell and Estill Counties produced 147,000 and 164,000 barrels, respectively. The three counties of Lee, Powell, and Estill accounted for 96 percent of the total Subregional oil production of 3.0 million barrels in 1965. The Subregional production was 15.4 percent of the total Kentucky crude oil production during this period.

The area has pipeline connections with the Ashland, Ky., refinery of Ashland Oil Company. Most of the crude oil production of the Subregion is marketed through this channel. Where the wells are not connected with the pipeline system, the oil must be transported by truck from the wells to the pipeline.

Natural Gas

Natural gas production in Subregion H, as estimated by the Kentucky Geological Survey, was 27 million cubic feet in 1965, with a value of $6.5 million. This was about 40 percent of the total Eastern Kentucky production of natural gas. A county distribution of natural gas production is not available.

Nonmetals

Limestone

Crushed limestone was produced from 10 counties of the Subregion in 1965; Table H-2 shows the quantity and value produced during 1961-65. In most cases the individual county production data must be concealed at the request of the producers. The total Subregional production was 1.7 million tons.

Building and highway construction are the principal uses of the crushed limestone. Soil neutralization in agriculture is another market. A small tonnage is used for railroad ballast. In 1965, 89.6 percent of the crushed limestone production was utilized for concrete aggregate and roadstone, 7.1 percent was used as agricultural stone, and 3.3 percent was used as railroad ballast.

An adequate supply of limestone is available for all future needs of the construction industry in the Subregion. No significant changes in future use patterns are anticipated, but total consumption should increase with increased population.

Clay

Clay for use in manufacture of heavy-clay products (brick and pipe) is produced at two open pit mines in Powell County. Ample reserves are available to meet future demand.

CONCLUSIONS

The mineral industry is important to the economy of Water Subregion H. In the eastern part of the Subregion, coal mining directly provides more than half of the personal income of the residents. Additional personal income is provided indirectly, through service and supporting industries such as timber, steel, petroleum, rubber, and plastics. In the western part of the Subregion, the mineral industry is a minor part of the economy; the minerals produced are clay, limestone, petroleum, and natural gas.

THE MINERAL INDUSTRY OF WATER SUBREGION I

by

Robert C. Johnson[1/]

ABSTRACT

The water Subregion consists of the Appalachian segment of the Cumberland River Basin in Kentucky and Tennessee. The mineral industry of Water Subregion I contributed an average of $60 million annually to the economy of the area during the period 1961 through 1965. Mineral production value rose from $53 million in 1961 to $62 million in 1962 and remained at this approximate level through 1965. Coal accounted for 84 percent of total mineral output value during this period. Other mineral commodities produced in the Subregion were crushed limestone, natural gas, petroleum, dimension and crushed sandstone, sand and gravel, and miscellaneous clay. Reserves known to exist within Subregion I for all commodities produced except petroleum and natural gas are adequate to sustain growth of the mineral industries for many years.

INTRODUCTION

Water Subregion I consists of that portion of the Cumberland River Basin in Appalachia (fig. I-1), comprising 18 counties in Kentucky and 12 in Tennessee. During 1961-65, annual mineral production value in the Subregion averaged $60 million, 84 percent of which was derived from coal. Total annual value of mineral output rose from $53 million in 1961 to $62 million in 1962, owing mainly to increased coal production, and remained at this approximate level through 1965 (table I-2). Other important minerals produced in the Subregion were crushed limestone, natural gas, petroleum, dimension and crushed sandstone, sand and gravel, and clay. Employment in mineral-related industries, total employment, and population for 1940-60 and projections to 2,000 are shown in table I-1. Mineral production and value in 1958 constant dollars, 1961-65, by commodities appears in table I-2. The value of 1965 mineral production in current dollars, by counties, and the minerals produced are listed in table I-3.

1/ Mining engineer, Knoxville Office of Mineral Resources, Bureau of Mines, U.S. Department of the Interior, Knoxville, Tenn.

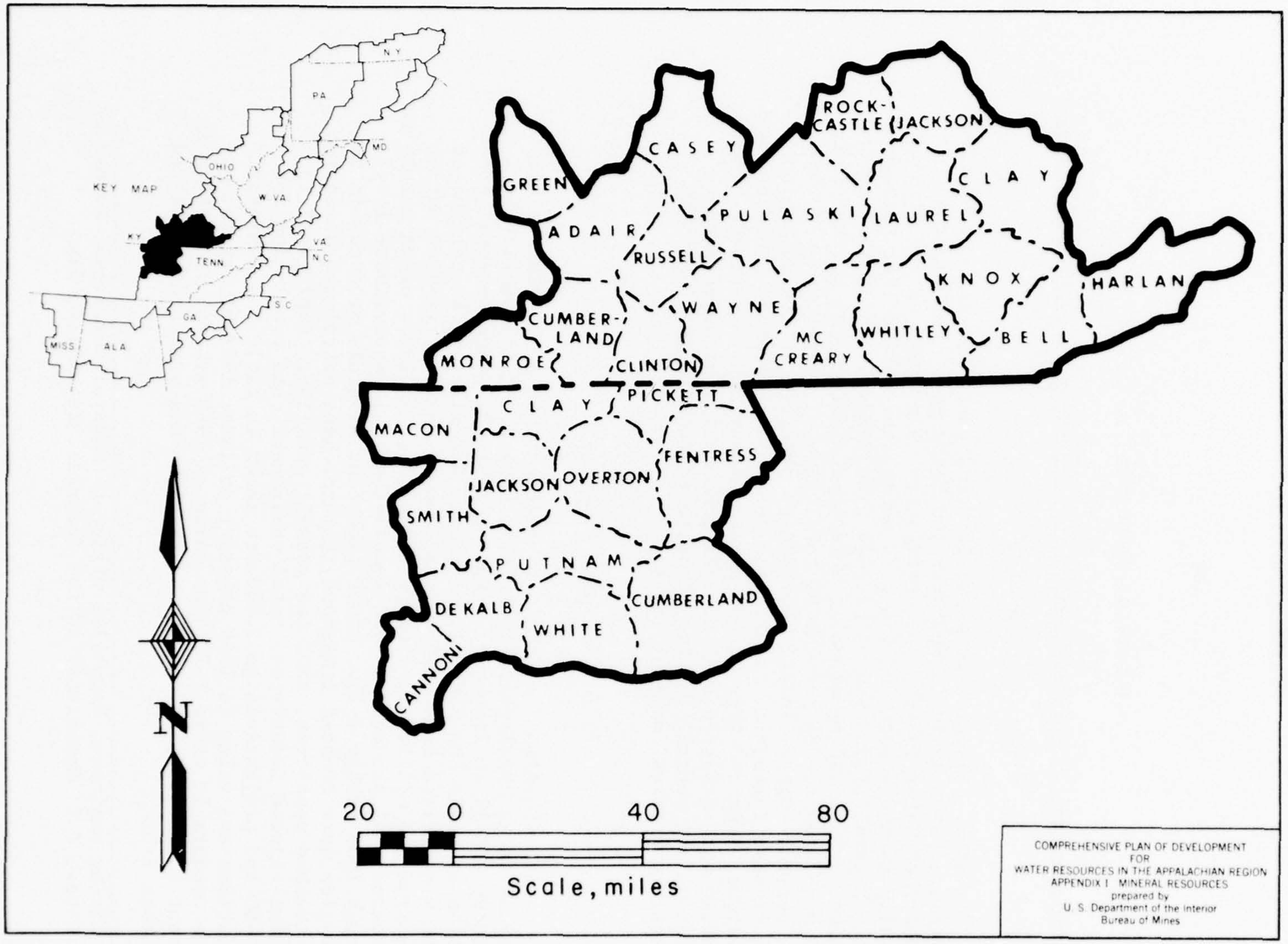

FIGURE I-1. - Water Subregion I.

TABLE I-1. - Employment in mineral-related industries, total employment and population, Water Subregion I, 1940-2000[1/]

Years	Mineral-related industries				Total employment	Total population
	Mining	Construction	Petroleum	Primary metals		
Employment and Population						
1940	24,080	3,857	-	-	156,421	609,410
1950	23,153	8,692	86	100	162,839	585,891
1960	10,085	8,281	441	195	132,348	495,493
1980	5,420	11,027	360	121	146,152	530,695
2000	4,840	13,685	360	104	197,329	620,262
Distribution of Employment (percent)						
1940	15.4	2.5	-	-	-	-
1950	14.2	5.3	0.1	0.1	-	-
1960	7.6	6.3	0.3	0.1	-	-
1980	3.7	7.5	0.2	0.1	-	-
2000	2.5	6.9	0.2	0.1	-	-
Change in Employment						
1940-1960	-13,995	+4,424	(2/)	(2/)	-24,073	-
1960-1980	-4,665	+2,746	-81	-71	+13,804	-
1980-2000	-580	+2,658	0	-17	+51,177	-
Relative Change in Employment (percent)						
1940-1960	-58.1	+114.7	(2/)	(2/)	-15.4	-
1960-1980	-46.3	+33.2	-18.4	-37.9	+10.4	-
1980-2000	-10.7	+24.1	0	-14.0	+35.0	-

1/ Population and employment from Office of Business Economics, Department of Commerce.
2/ Indeterminate.

TABLE I-2. - Mineral production and value in Water Subregion I, 1961-65

Mineral	1961	1962	1963	1964	1965
Production:					
Coal (Bituminous).thousand short tons.	9,061	10,732	10,840	11,554	11,246
Natural gas.......million cubic feet..	6,970	6,820	6,870	6,750	6,850
Petroleum (crude).thousand 42-gal. barrels............................	1,322	759	514	353	351
Stone............thousand short tons.	3,135	3,456	3,657	3,274	3,439
Value, thousand constant 1958 dollars:					
Coal (Bituminous)....................	42,189	52,847	51,651	53,986	53,691
Natural gas..........................	1,733	1,674	1,626	1,602	1,612
Petroleum (crude)....................	3,917	2,208	1,482	1,030	1,003
Stone................................	5,165	5,471	6,681	5,684	5,611
Items that cannot be disclosed:					
Clays, sand, and gravel..........	178	222	207	160	158
Total..................	53,182	62,422	61,647	62,462	62,075

TABLE I-3. - Value of mineral production in Water Subregion I, by States and counties, 1965[1]

State and county	Value in current dollars	Minerals produced in order of value[2]
Kentucky:		
Adair..........	W	Limestone, petroleum.
Bell...........	$6,891,974	Coal, petroleum.
Casey..........	190,051	Limestone, petroleum.
Clay...........	5,954,240	Coal, petroleum.
Clinton.........	W	Petroleum, limestone, coal.
Cumberland......	W	Petroleum, limestone.
Green..........	W	Limestone, petroleum.
Harlan..........	W	Coal, limestone.
Jackson.........	W	Limestone, coal, petroleum.
Knox...........	W	Coal, miscellaneous clay, petroleum.
Laurel..........	W	Coal, limestone, petroleum.
McCreary........	1,677,831	Coal, petroleum.
Monroe..........	222,015	Limestone, petroleum.
Pulaski.........	W	Coal, limestone.
Rockcastle......	W	Limestone.
Russell.........	5,384	Petroleum.
Wayne..........	W	Limestone, coal, petroleum.
Whitley.........	2,197,578	Coal, petroleum.
Tennessee:		
Cannon..........	(3/)	Limestone.
Clay...........	W	Do.
Cumberland......	1,625,182	Sandstone, limestone, sand and gravel, coal.
Fentress........	542,371	Limestone, coal, sandstone.
Macon..........	W	Limestone.
Overton.........	W	Limestone, coal.
Pickett.........	47,093	Do.
Putnam..........	W	Coal, limestone, sand and gravel.
White..........	W	Limestone.
Undistributed[4]...	38,181,451	
Total.......	57,535,170	

W Withheld to avoid disclosing individual company confidential data; included with "Undistributed".

1/ Value of natural gas for the Subregion is included with "Undistributed"; individual county data were not available. The following Tennessee counties did not report mineral production: DeKalb, Jackson, and Smith.

2/ Other than natural gas.

3/ Cannon County, Tenn., value is excluded from total.

4/ Includes values for natural gas and values indicated by symbol W. Excludes value of limestone in Cannon County, Tenn.

MINERAL RESOURCES OF SUBREGION I

Fuels

Bituminous Coal

The eastern part of Subregion I lies within the Tennessee and eastern Kentucky coalfields. Coal production in 1965 was from 16 of the 30 counties and accounted for 86 percent of the mineral output value of the Subregion. Counties with coal production in 1965 were Bell, Clay, Clinton, Harlan, Jackson, Knox, Laurel, McCreary, Pulaski, Wayne, and Whitley in Kentucky; and Cumberland, Fentress, Overton, Pickett, and Putnam in Tennessee. In 1965, 413 mines were operated; 78 percent were in Harlan, Bell, Clay, and Whitley Counties, Ky. Harlan County alone contained 136 operating mines in 1965. Coal from the Subregion was sold on the open market and to electric utilities. Reserves within the Subregion are apparently adequate for sustained growth in mining.

Oil and Gas

During 1961-65, oil production in Subregion I declined from 1.3 to 0.3 million barrels. At the same time, the total oil output for Kentucky remained fairly consistent. All Kentucky counties in the Subregion except Harlan and Pulaski produced oil during this period.

The county in Kentucky with greatest production of oil was Green, which in 1961 produced 962,900 barrels, or 73 percent of the output of the Subregion, in 1965 it produced 136,000 barrels, or 39 percent of the Subregion total. Other leading counties in Kentucky were Clinton, Cumberland, Wayne, and Whitley.

Monroe County, Ky., showed a gain from 4,000 barrels of oil in 1964 to 23,000 barrels in 1965 owing to new oil discoveries late in 1965 near Sulphur Lick. Production from the Sulphur Lick area was reported to have increased after 1965 but to have declined later. New oil discoveries in the Subregion are infrequent, and there is no indication that the overall downward production trend will be reversed.

Natural gas data for Kentucky on a county basis are not available but total production and value for the Subregion were estimated by the State geologist. Oil and/or gas was produced in all Tennessee counties in the Subregion except Cumberland, DeKalb, and White.

Nonmetals

Limestone

Crushed limestone, produced in 23 of the 30 Subregion counties, rose in value from \$4.3 million in 1961 to \$5.4 million in 1963, dropped to \$4.7 million in 1964, and rose slightly to \$4.8 million in 1965. Crushed limestone is of low unit value, and transportation cost is a critical factor in marketing. Because of this, limestone quarries are widely scattered throughout the Subregion. Most of the Subregion counties without limestone production are situated in the mountainous coal area of eastern Kentucky which contains very little easily accessible limestone, even though extensive reserves may exist below drainage in Mississippian formations. In 1965, four companies producing crushed limestone employed 143 men in six underground mines, and 19 companies employed 300 men at 20 quarries.

Crushed limestone production is usually closely tied to a region's economic and industrial growth, because most of the product is used in construction. Another important use of limestone within this Subregion is for agricultural purposes. Ample limestone reserves are present in the Subregion to allow increased production for many years.

Sandstone

During 1961-65, dimension sandstone was produced in three Subregion counties (Cumberland and Fentress Counties, Tenn., and McCreary County, Ky.). Production from McCreary County, however, was very small and limited to 1961-62. Crushed sandstone output, produced only in 1962-65, was also very small and was limited to Cumberland County.

Total annual sandstone production from the three counties ranged from 37,000 to 41,000 short tons during 1961-64, but dropped in 1965 to 34,000 short tons. Annual value of output during this time ranged from a high of \$1.3 million in 1963 to a low of \$0.8 million in 1965. Even though production was lower in 1965, combined output of dimension sandstone from Cumberland and Fentress Counties comprised 9 percent of total national production.

The dimension sandstone is marketed nationally under a number of trade names for use in building construction and as flagstone. During 1965, 13 companies operated 13 dimension sandstone quarries in Cumberland and Fentress Counties. Considerable reserves exist, especially in Cumberland County.

Crushed sandstone was produced from one quarry in Cumberland County. Subregion output of crushed sandstone should increase, because two new operations were recently opened in Cumberland County about 2 miles southwest of Crab Orchard, Tenn.

Sand and Gravel

Sand and gravel production in Subregion I was from two Tennessee operations, one in Cumberland County and the other in Putnam County. Sand and gravel was used in construction and paving. Production figures are withheld to avoid disclosing individual company confidential data, but a sizable decrease in output occurred during 1961-65. Reserves are adequate to allow a higher level of production than is now being achieved.

Clay

Clay production in Subregion I was from one operation in Whitley County, Ky., in 1961-64, and from another mine in Knox County, Ky., in 1965. Both operations were mined by the same company. The clay was used in manufacturing brick and tile. While individual company data are confidential, total output has remained at about the same level. Sufficient reserves are present to allow expansion of the clay industry in Subregion I.

CONCLUSIONS

The mineral industry of Subregion I is highly important to the economy of the area but is not presently growing. Coal, the most significant mineral commodity produced, contributed $54 million of the $62 million mineral output in 1965. Coal production rose 1.7 million tons from 1961 to 1962 but remained at about the 1962 level through 1965. Reserves of coal are adequate in the Subregion to sustain rapid growth for many years.

The second most important mineral commodity in Subregion I is crushed limestone, which during 1961-65 contributed $4.3 million to $5.4 million annually to the economy of the Subregion. During the same period, the annual value of petroleum output decreased from $3.9 million to $1 million, natural gas value remained at about $1.6 million to $1.7 million, and sandstone production ranged from $0.8 million to $1.3 million. Of lesser importance were sand and gravel and clay. Reserves of limestone, sand and gravel, and miscellaneous clay are ample to sustain higher levels of production, but changes in local demand for these low-cost, construction-related products will to a large extent dictate growth or decline in their development.

The *dimension sandstone* produced in Cumberland and Fentress Counties, Tenn., is a high-unit-price item with a small but widespread market for building purposes and for flagstone. Reserves of this attractive building stone are adequate for higher levels of production.

Crushed sandstone production, previously of minor significance, will increase because of two new operations in Cumberland County, Tenn. Petroleum reserve data in the Subregion are not available, but a steady decline in production during 1961-65 indicates that known reservoirs were being depleted faster than new discoveries were being made. There is no indication that the downward trend of *the Subregion in oil production will be reversed.*

THE MINERAL INDUSTRY OF WATER SUBREGION J

by

Vernal A. Danielson[1/] and F. Vernon Tompkins[1/]

ABSTRACT

Total value of mineral production in Subregion J in 1965 was \$294.2 million. Bituminous coal comprised \$175.1 million, or 60 percent of this total. Production of stone, zinc, and portland cement also were important. Projected employment in the mineral industries of Subregion J will decrease 9 percent from 1960 to 1980, then increase 16 percent from 1980 to 2000.

INTRODUCTION

Water Subregion J embraces the Appalachian section of the Tennessee River and its tributaries. The Subregion includes nine counties in northern Alabama, 38 counties in eastern Tennessee, eight counties in western Virginia, 15 counties in western North Carolina, and three counties in northwestern Georgia. Figure J-1 is a map of the Subregion and shows its location within Appalachia. The Tennessee River and its tributaries drain 87 percent of Subregion J.

The mineral industry of Subregion J is an important segment of the area's economy, directly employing about 25,000 people, or 3.0 percent of the Subregion's total 1962 employment of 855,000. The Office of Business Economics, Department of Commerce, has projected the employment in mineral-related industries in the Subregion to the year 2000 (table J-1). Employment in mining is projected to increase about 6 percent in 1960-2000, while total employment is expected to double in the same period. This is possible in view of the increasing automation of coal mines and some shifting away from coal as an energy source.

The total value of mineral production in the Subregion in 1965 was \$294.2 million. Sixty percent of this production value, or \$175.1 million, was derived from bituminous coal, produced in western Virginia and in eastern Tennessee. Next in value of production was stone, dimension and crushed, which amounted to \$38.5 million, or 13 percent of the total value of production in 1965. Zinc was next in value with \$26.3 million, or 9 percent, followed by portland cement, copper, sand and gravel, scrap mica, natural gas, clays, barite, silver, petroleum,

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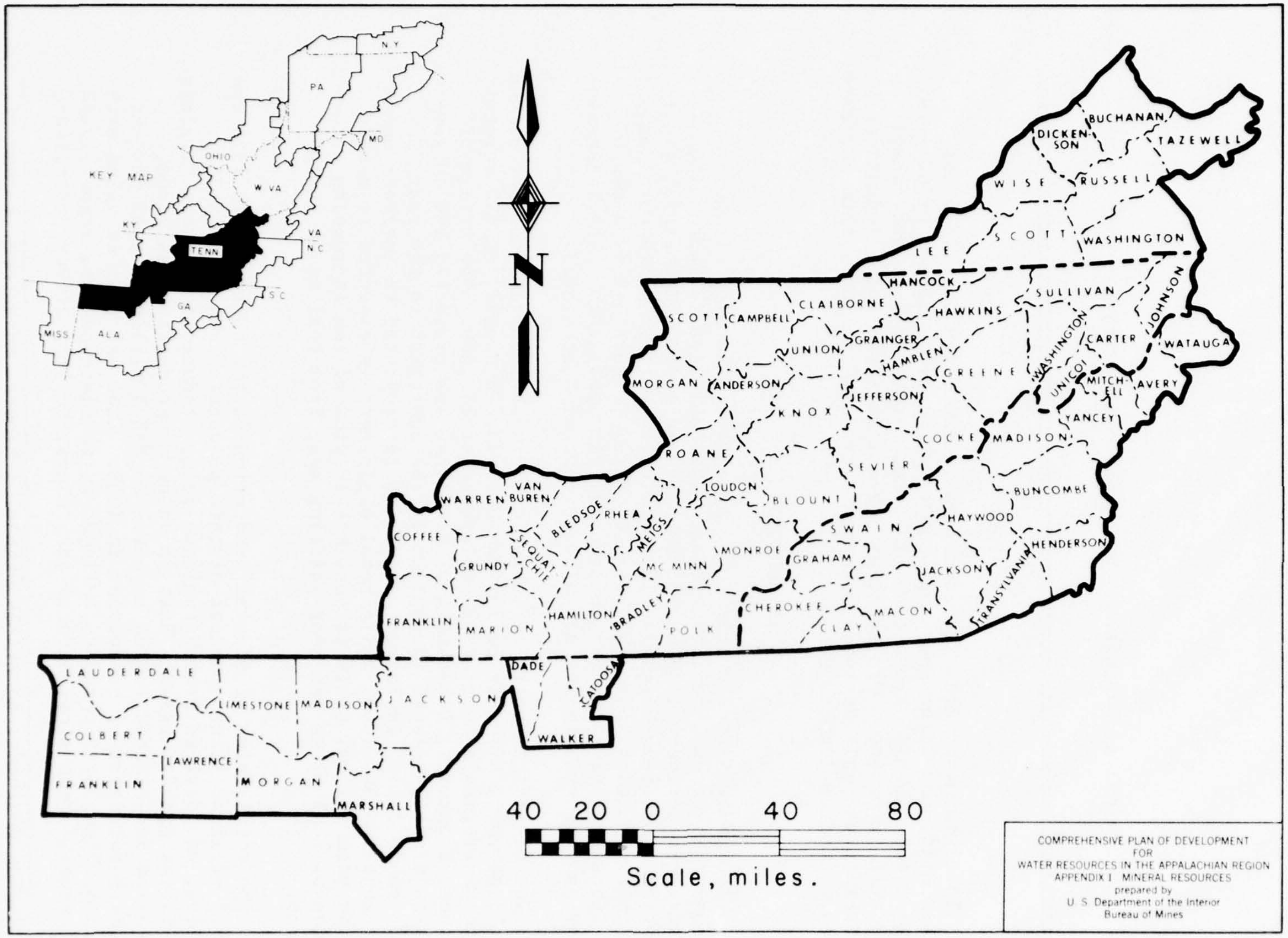

FIGURE J-1. - Water Subregion J.

TABLE J-1. - Employment in mineral-related industries, total employment, and population, Water Subregion J, 1960-2000 1/

Years	Mineral-related industries				Total employment	Total population
	Mining	Construction	Petroleum	Primary metals		
			Employment and Population			
1960	24,735	61,513	331	16,744	854,615	2,629,763
1980	22,588	86,492	-	26,200	1,271,308	3,681,073
2000	26,248	118,749	-	29,400	1,877,605	5,260,820
			Distribution of Employment (percent)			
1960	2.9	7.2	(2/)	2.0	-	-
1980	1.8	6.8	-	2.1	-	-
2000	1.4	6.3	-	1.6	-	-
			Change in Employment			
1960-1980	-2,147	+24,979	-331	+9,456	+416,693	-
1980-2000	+3,660	+32,257	-	+3,200	+606,297	-
			Relative Change in Employment (percent)			
1960-1980	-8.7	+40.6	-100.0	+56.5	+48.8	-
1980-2000	+16.2	+37.3	-	+12.2	+47.7	-

1/ Population and employment data from Office of Business Economics, Department of Commerce.
2/ Less than 0.1 percent.

and gold, in that order. Other mineral commodities produced in 1965, whose values cannot be disclosed, were asbestos, asphalt, feldspar, gypsum, iron ore, lime, olivine, pyrites, talc, and tripoli. Table J-2 gives mineral production and value in 1961-65, while table J-3 gives value of mineral production by State and county in 1965.

MINERAL RESOURCES OF SUBREGION J

Fuels

Bituminous Coal

Bituminous coal is the most important mineral commodity produced in Subregion J. In 1965, production was 39.9 million tons, having a value of $175.1 million, or 60 percent of the total value of mineral production in the Subregion. Annual production of coal in the Subregion increased 5 percent from 1961 to 1964, and 7 percent from 1964 to 1965.

Distribution of coal production as percentages of the total tonnage mined in the Subregion in 1965, was as follows:

	Percent
Buchanan County, Va	38.3
Dickenson County, Va	22.2
Wise County, Va	18.3
Anderson County, Tenn	5.1
Russell County, Va	4.4
Campbell County, Tenn	2.7
Marion County, Tenn	1.6
Scott County, Tenn	1.3
Lee County, Va	1.3
Tazewell County, Va	1.0
Claiborne, Grundy, Hamilton, Morgan, Rhea, Sequatchie, and Van Buren Counties, Tenn.; Walker County, Ga.; and Jackson County, Ala	3.8
Total	100.0

All of Virginia's bituminous coal production in 1965, with minor exceptions, was from Subregion J. Eighty-six percent of the coal was mined by underground methods, 9 percent by stripping, and 5 percent by augering. There were 1,153 underground mines, 56 strip mines, and 62 auger mines. Mechanical methods of cutting and loading are rapidly increasing in the underground mines, indicating a strong trend toward modernization and mechanization.

TABLE J-2. Mineral production and value in Water Subregion J, 1961-65

Mineral	1961	1962	1963	1964	1965
Production:					
Barite................short tons..........	W	13,797	24,082	39,188	30,532
Cement:					
Portland and masonry.thousand 376-lb. bbl.	7,848	7,967	7,790	7,786	8,281
Clays.................thousand short tons..	981	1,003	1,077	1,005	929
Coal (bituminous)...............do.........	35,553	35,008	36,024	37,221	39,875
Copper................short tons..........	12,272	14,298	13,717	13,889	14,823
Gem stones................................	NA	NA	NA	-	-
Gold (recoverable content of ores, etc.)					
....................troy ounces.........	157	158	137	133	122
Lead..................short tons..........	-	51	-	-	-
Mica:					
Sheet...............pounds...............	243,084	60,785	-	72,460	-
Scrap...............thousand short tons..	44	49	45	49	52
Natural gas...........million cubic feet...	-	-	2,085	1,609	3,152
Petroleum (crude)......thousand 42-gal. bbl.	6	3	3	6	4
Sand and gravel........thousand short tons..	3,054	4,239	3,433	3,866	3,848
Silver (recoverable content of ores, etc.)					
....................troy ounces.........	83,419	112,251	107,913	90,539	94,142
Stone.................thousand short tons..	21,955	23,042	24,328	24,804	28,014
Zinc (recoverable content of ores, etc.)					
....................short tons..........	81,734	71,548	95,847	115,943	122,387
Value, thousand 1958 constant dollars:					
Barite....................................	W	230	410	512	431
Cement:					
Portland and masonry.....................	24,636	25,265	24,663	24,740	25,825
Clays.....................................	716	926	934	939	887
Coal (bituminous).........................	154,027	149,835	156,305	157,485	175,091
Copper....................................	6,510	7,720	7,341	7,256	7,711
Gem stones................................	(1/)	1	(1/)	-	-
Gold......................................	5	6	4	4	3
Lead......................................	-	7	-	-	-
Mica:					
Sheet....................................	2,179	794	-	10	-
Scrap....................................	767	1,106	1,016	1,009	1,263
Natural gas...............................	-	-	483	479	939
Petroleum (crude).........................	-	-	7	13	8
Sand and gravel...........................	3,772	4,724	4,468	5,019	5,262
Silver....................................	76	113	119	100	105
Stone.....................................	32,982	33,260	34,999	35,738	38,458
Zinc......................................	16,622	14,422	19,153	25,269	26,258
Items that cannot be disclosed:					
Asbestos, asphalt (native), feldspar, gypsum, iron ore, lime, olivine, pyrites, talc, tripoli (1965), and item indicated by symbol W..............................	12,387	11,928	11,350	10,952	11,986
Total...............................	254,679	250,337	261,252	269,525	294,227

NA Not available.
W Withheld to avoid disclosing individual confidential company data.
1/ Less than $500.

TABLE J-3. - Value of mineral production in Water Subregion J, by States and counties, 1965

State and county	Value in current dollars	Minerals produced in 1965 in order of value
Alabama:		
Colbert.......	W	Limestone, native asphalt.
Franklin......	$3,641,954	Iron ore, limestone, sand and gravel, fire clay.
Jackson.......	1,002,671	Bituminous coal, limestone.
Lauderdale....	W	Tripoli.
Lawrence......	-	
Limestone.....	76,540	Limestone.
Madison.......	W	Limestone, miscellaneous clay.
Marshall......	390,290	Limestone, sandstone.
Morgan........	W	Limestone, sand and gravel.
Georgia:		
Catoosa.......	-	
Dade..........	W	Limestone.
Walker........	W	Do.
North Carolina:		
Avery.........	W	Mica, kaolin, sand and gravel.
Buncombe......	1,380,008	Sand and gravel, granite.
Cherokee......	W	Marble, talc.
Clay..........	-	
Graham........	-	
Haywood.......	W	Sand and gravel.
Henderson.....	464,557	Limestone, granite, miscellaneous clay.
Jackson.......	W	Granite, olivine.
Macon.........	130,782	Granite, limestone, mica, sand and gravel.
Madison.......	W	Sand and gravel, feldspar.
Mitchell......	W	Feldspar, mica, sand and gravel, sandstone, kaolin.
Swain.........	152,634	Limestone.
Transylvania..	-	
Watauga.......	W	Sand and gravel.
Yancey........	568,860	Mica, olivine, feldspar, sand and gravel, asbestos.
Tennessee:		
Anderson......	W	Bituminous coal, limestone, miscellaneous clay.
Bledsoe.......	50,046	Bituminous coal.
Blount........	W	Limestone, marble.
Bradley.......	W	Limestone.

TABLE J-3. - Value of mineral production in Water Subregion J, by States and counties, 1965 (continued)

State and county	Value in current dollars	Minerals produced in 1965 in order of value
Tennessee - Continued		
Campbell......	W	Bituminous coal, limestone, sandstone.
Carter........	W	Limestone.
Claiborne.....	W	Bituminous coal, limestone.
Cocke.........	$97,500	Limestone.
Coffee........	W	Do.
Franklin......	W	Cement, limestone, sandstone, sand and gravel, miscellaneous clay.
Grainger......	96,232	Limestone, marble.
Greene........	W	Limestone, sand and gravel.
Grundy........	W	Bituminous coal, limestone, sand and gravel.
Hamblen.......	W	Limestone.
Hamilton......	9,676,019	Cement, limestone, sand and gravel, bituminous coal, miscellaneous clay.
Hancock.......	W	Zinc, limestone.
Hawkins.......	W	Limestone.
Jefferson.....	W	Zinc, limestone.
Johnson.......	W	Limestone.
Knox..........	16,700,923	Cement, zinc, limestone, lime, marble, sand and gravel, miscellaneous clay.
Loudon........	W	Barite, sand and gravel, miscellaneous clay.
Marion........	W	Cement, bituminous coal, limestone.
McMinn........	W	Limestone, barite, sand and gravel.
Meigs.........	W	Limestone.
Monroe........	761,128	Limestone, sand and gravel.
Morgan........	1,224,574	Bituminous coal.
Polk..........	W	Copper, pyrites, zinc, silver, sand and gravel, gold.
Rhea..........	298,160	Limestone, bituminous coal.
Roane.........	W	Limestone.
Scott.........	1,593,549	Bituminous coal.
Sequatchie....	W	Limestone, bituminous coal.
Sevier........	W	Sand and gravel, limestone.
Sullivan......	W	Cement, limestone, miscellaneous clay.
Unicoi........	W	Sand and gravel, limestone.
Union.........	W	Marble, limestone.
Van Buren.....	874,850	Bituminous coal.
Warren........	W	Limestone.
Washington....	W	Limestone, miscellaneous clay.

TABLE J-3. - Value of mineral production in Water Subregion J, by States and counties, 1965 (continued)

State and county	Value in current dollars	Minerals produced in 1965 in order of value
Virginia:		
Buchanan......	$60,253,326	Bituminous coal, natural gas.
Dickenson.....	37,737,420	Bituminous coal, natural gas, sand and gravel.
Lee...........	W	Bituminous coal, stone, petroleum.
Russell.......	10,146,670	Bituminous coal, stone, clay.
Scott.........	1,116,398	Stone, bituminous coal.
Tazewell......	W	Stone, bituminous coal, natural gas, lime, clay.
Washington....	1,840,052	Stone, gypsum.
Wise..........	29,383,306	Bituminous coal, stone.
Undistributed...	113,233,976	
Total.......	292,892,425	

W Withheld to avoid disclosing individual company confidential data; included with "Undistributed" for the State.

Almost all of Tennessee's coal production is from the section lying in Subregion J, accounting for 94.7 percent of the total production in 1965. Sixty-one percent of the coal was mined by underground methods. Strip mining is more prevalent in this area than in Virginia, accounting for about 35 percent; 4 percent was mined by augering.

In 1965, 55 percent of the Tennessee coal was shipped by rail or water to Tennessee Valley Authority (TVA) steamplants, a considerable reduction from the 68 percent shipped to TVA in 1964; the loss resulted from competitive coal being imported into the Subregion. The remaining 45 percent of the 1965 production was marketed for industrial and domestic uses.

The outlook for the coal industry is clouded by the increasing substitution of nuclear fuels for coal as an energy source in electric power generation. In spite of this substitution, however, the total consumption of coal will increase because of the tremendous increase in demand for electricity by an expanding economy and a rising population. Abundant reserves of bituminous coal are present in Subregion J to meet future demand.

Natural Gas

Natural gas production in Subregion J in 1965 was from Buchanan, Dickenson, and Tazewell Counties, Va. Natural gas is not as important as some of the other mineral commodities in the Subregion, no production having been reported in 1961-62. Value of production in 1965 was $939,000 (1958 constant dollars), about 0.3 percent of the total subregional value of minerals for that year.

Natural gas from Buchanan and Tazewell Counties was delivered to the pipelines of Atlantic Seaboard Co. and Hope Natural Gas Co. Dickenson County production was delivered to Kentucky-West Virginia Gas Co. pipelines.

Petroleum (crude)

The only petroleum production reported from Subregion J during 1961-65 was from Lee County, Va. Production (from the Ben Hur and Rose Hill fields) was 3,617 barrels from six wells in 1965.

Nonmetals

Asbestos

Amphibole asbestos was produced in Yancey County, N.C., by Powhatan Mining Co. Production of asbestos decreased 1 percent per year from 1961 to 1965. Amphibole asbestos was marketed nationally for use in chemical-resistant filters, as a coating for welding rod, and as fillers in various products. Reserves are unpredictable because amphibole asbestos occurs in relatively small veins and lenses.

Asphalt

Native asphaltic limestone was produced in Alabama in Colbert County, by Alabama Asphaltic Limestone Co. Production increased an average of 9 percent per year from 1961 to 1965, and value increased 23 percent per year. Crushed asphaltic limestone was marketed locally for surfacing roads. Beds of limestone and sandstone containing asphalt are extensive in northwestern Alabama.

Barite

Crude barite was produced in McMinn and Loudon Counties, Tenn., by three companies at five mines. The leading producer was Godsey Mines, Inc., in McMinn County. From 1962 to 1965, barite production increased an average of 40 percent per year in tonnage and 29 percent per year in value. Production in the Subregion in 1965 was 4 percent of the national total. Barite was sold in both regional and national markets for oil-well-drilling mud, chemicals, and other uses. Reserves of barite are sufficient for continued production at the present rate for many years.

Cement

Cement was produced in Franklin, Hamilton, Knox, Marion, and Sullivan Counties, Tenn. Value of cement production was about 9 percent of the total Subregional mineral production in 1965.

Raw materials used in the manufacture of cement were limestone (60 percent), cement rock (26 percent), clays and shales (9 percent), gypsum (3 percent), and other materials (2 percent).

Plant capacities are adequate, or can be expanded, to meet future demand.

Clay

Clay was less important than other mineral commodities in Subregion J. The value of clay produced was $887,000, or 0.3 percent of the total value of mineral production in 1965. Production was well distributed throughout the Subregion. Clay was used for manufacture of building brick, heavy clay products, lightweight aggregate, and cement. Reserves are ample to meet demand in the foreseeable future.

Feldspar

More than 40 percent of the crude feldspar produced nationally in 1965 was mined in Mitchell and Yancey Counties, N.C. Leading producers were International Minerals and Chemical Corp., The Feldspar Corp., and Lawson-United Feldspar and Minerals Co.; all have mines in Mitchell County. Several small producers mined lump feldspar in Yancey and

Mitchell County. Feldspar output increased an average of 3 percent per year in tonnage and 7 percent per year in value from 1961 to 1965. Ground feldspar, which was marketed nationally, was used mainly in the manufacture of glass and pottery. A small amount of ground feldspar was used for enamel. Reserves of feldspar are extensive.

Gypsum

Gypsum was mined, calcined, and manufactured into plasterboard and other gypsum building products at the Plasterco plant of United States Gypsum Co. in Washington County, Va.

Gypsum was also mined from a nearby quarry in Smyth County, Va., outside of Subregion J, by the United States Gypsum Co. for processing in the Plasterco plant. Production of crude gypsum in Washington County decreased more than 10 percent per year from 1961 to 1965.

Lime

Quicklime and hydrated lime were produced in Knox County, Tenn., by Foote Mineral Co. and Williams Lime Manufacturing Co. Production of lime increased an average of 3 percent per year from 1961 to 1965. Lime was marketed locally and in States adjacent to Tennessee for building and chemical uses. Reserves of limestone for the manufacture of lime are extensive.

Mica

Scrap, sheet, and punch mica were produced in the Subregion in North Carolina; most of the tonnage and value was in scrap mica. Mica production in 1965 was reported from 11 mines in four counties. Leading producers of scrap mica were Southern Mica Co. of North Carolina, in Mitchell County, and Deneen Mica Co. and Harris Clay Co., both in Yancey County. From 1961 to 1965, production of scrap mica increased an average of 4 percent, while value increased 10 percent per year. Scrap mica mined in the Subregion in 1965 was about 40 percent of the national production.

Ground mica, a product of scrap mica, was marketed nationally for use as a coating for roofing, as an ingredient in joint cement for plasterboard, and as a filler in paint and rubber. Scrap mica reserves are adequate for the foreseeable future.

Olivine

Olivine was produced in Subregion J in Jackson County, N.C., by Harbison-Walker Refractories Co., Balsam Gap Co., and Northwest Carolina Olivine Co. in Yancey County, N.C. Production of olivine increased from 1961 to 1965 at an average of 7 percent per year and in value an average

of 23 percent per year. Olivine, which was marketed locally and regionally, was used for refractories, molding sand, and slag conditioner.

Pyrite

Pyrite was produced in the Subregion as a concentrate from sulfide ores mined in Polk County, Tenn., by Tennessee Copper Co. Annual production of pyrite from 1961 to 1965 increased slightly, but with a slight decrease in value due to lower unit prices.

Pyrite was roasted and sintered to produce sulfur dioxide gas and iron sinter. A minor part of the sulfur dioxide gas was compressed and sold as liquid sulfur dioxide; the major part was made into sulfuric acid.

The sulfuric acid was sold on regional markets and also used by the company in compounding other industrial and agricultural chemicals. The iron sinter, which is exceptionally high in quality, was sold to producers of iron and steel in the Eastern United States.

Sand and Gravel

Production of sand and gravel was well distributed throughout the Subregion in 1965, with 20 of 73 counties reporting production. A total of 3.8 million tons, valued at $5.3 million, was produced. None of the counties was particularly dominant in production. Major uses of the sand and gravel were for concrete aggregate, roadstone, molding sand, and railroad ballast.

Because of its low unit value, transportation costs limit the market areas of sand and gravel operations. Portable plants are often used to reduce haulage distances when the demand is limited or of temporary nature. Crushed stone is interchangeable with sand and gravel for most uses and is often substituted for it. Reserves of sand and gravel, although ample in most areas, are often lost by urban expansion, deposits being zoned out for other uses or covered by roads and buildings. As a result, it is sometimes necessary to transport sand and gravel much farther than if such factors had been considered in early planning.

Stone

Granite (crushed)

Six quarries in Buncombe, Henderson, Jackson, and Macon Counties, N.C., produced and crushed granite for concrete aggregate and roadstone in 1965. Production from these operations was 646,000 tons, valued at $851,000. Ample reserves are available.

Limestone (crushed)

The crushed limestone industry is widely distributed throughout the Subregion. Production was reported from 44 of the 73 counties of the Subregion in 1965. Chief uses of the crushed limestone were concrete aggregate and roadstone. Other uses were for cement, lime, metallurgical flux, agriculture, and chemicals. A total of 23.4 million tons of crushed limestone were produced in 1965, of which 16.5 million tons were from Tennessee. Reserves are ample for future demand.

Limestone (dimension)

Dimension limestone was produced in Franklin County, Ala., by Georgia Marble Co., and in Walker County, Ga., by H. R. Perry Stone Co.

Marble (crushed)

Columbia Marble Co., Cherokee County, N.C., John J. Craig Co., Blount County, Tenn., and Knoxville Crushed Stone Co. and Appalachian Marble Co., both in Knox County, Tenn., quarried and crushed marble for terrazzo, fillers, and other uses.

Marble (dimension)

Dimension marble was produced by Columbia Marble Co., Cherokee County, N.C., and by several companies in Blount, Grainger, and Knox Counties, Tenn., for use as rough and dressed building stone and monumental stone. Reserves are considered adequate for needs in the foreseeable future.

Sandstone (crushed)

Crushed sandstone was produced in the Subregion in Tennessee by White Silica Sand Co., Campbell County, and Sewanee Silica Company, Franklin County, for concrete, roads, abrasives, and manufacture of glass.

Tripoli

A narrow band of tripoli deposits extends southwest from Wayne County, Tenn., into Lauderdale County, Ala., and along Bear Creek in Colbert County, Ala. Tripoli deposits also occur in northwest Georgia within the Subregion. All the deposits are derived from the decomposition or alteration of chert. The major use of tripoli is as an abrasive. It is also used as a filler and in drilling mud.

A small quantity of tripoli was mined in 1965 by Alasil Corp., near Waterloo, Lauderdale County, Ala.

Metals

Copper

Copper ore was mined in the Subregion in Polk County, Tenn., from mines of Tennessee Copper Co. Copper concentrate was roasted and smelted to produce blister copper containing minor quantities of gold and silver, sulfur dioxide gas was used for making sulfuric acid, and the granulated slag was sold locally as an ingredient for cement. From 1961 to 1965, production of blister copper increased an average of 5 percent per year in tonnage and 11 percent per year in value. A major part of the blister copper is shipped to the eastern seaboard for electrolytic refining; the remainder is retained and used for compounding chemicals.

A spectrum of mineral-dependent commodities, ranging from metallic concentrates to compounded chemicals, is produced from the metallic sulfide ore which is economic only when the value of the sulfur is added to the value of the metals. Products from the Tennessee Copper Co. mill are pyrite, copper concentrate, and zinc concentrate. Marketable products include blister copper, zinc concentrate, gold and silver, granulated slag, iron sinter, sulfuric acid, liquid sulfur dioxide, and other industrial and agricultural chemicals.

Gold and Silver

Gold and silver were recovered as byproducts in the electrolytic refining of the blister copper of Tennessee Copper Co. Production of gold decreased an average of 5 percent per year from 1961 to 1965, while silver production increased an average of 3 and 10 percent per year in quantity and value, respectively, for the same period.

Iron Ore

Shook and Fletcher Supply Co., U. S. Pipe and Foundry Co., and Walston Hester & T. E. Farned mined brown iron ore (limonite) in Franklin County, Ala. Small quantities of limonite were mined in Blount County, Tenn., in 1961-63. In the same period Rockwood Mining Co. mined red iron ore (hematite) in Roane and Union Counties, Tenn. A small tonnage of magnetite was produced in Avery County, N.C., in 1961-63, and shipped to Atlanta, Ga., for processing.

The limonite produced in Franklin County, Ala., is shipped to blast furnaces in Birmingham, Ala. Reserves of limonite in Franklin County are extensive.

Zinc

Twenty percent of the zinc produced nationally in 1965 was from the Subregion. Zinc was produced in Tennessee in four counties by five companies at 13 mines. Producers were American Zinc. Co. in Jefferson and Knox Counties, New Jersey Zinc Co. in Jefferson and Hancock Counties, United States Steel Co. and New Market Zinc Co. in Jefferson County, and Tennessee Copper Co. in Polk County. From 1961 to 1965 production increased an average of 12 percent per year and value 15 percent per year.

Zinc ore was milled locally, and zinc concentrates were shipped to smelters in Illinois, Ohio, Oklahoma, Pennsylvania, and Texas.

CONCLUSIONS

The mineral industry of Subregion J contributed about $294.2 million to the basic economy of the area in 1965. Bituminous coal was the major mineral commodity in the Subregion, comprising 60 percent of the total value on an at-the-mine basis. Other important minerals were stone, zinc, and portland cement. Abundant reserves are available for needs in the foreseeable future.

PART 3. - WATER USE BY THE MINERAL INDUSTRY IN APPALACHIA

by

Walter C. Lorenz[1/]

ABSTRACT

The quantity of water needed by the mineral industry in Appalachia, the sources of water used, and the per ton requirements for preparing minerals are described in this report.

Appalachia extends from southern New York to central Alabama. The mineral-producing industry in Appalachia used 189.2 billion gallons of water in 1962. Of this total, about 66 percent was obtained directly from surface water sources, about 21 percent from mines, and about 11 percent from ground-water sources; the remaining 2 percent was purchased from external sources.

Stream pollution from mineral industry waste and waste water will tend to decrease in the future as a result of new State laws and current intensified research programs aimed at eliminating the polluting effects of mine water.

INTRODUCTION

The Appalachian Region extends from southern New York to central Alabama. This report deals with 373 counties in portions of New York, Pennsylvania, Ohio, Maryland, Virginia, Kentucky, North Carolina, Tennessee, South Carolina, Georgia, and Alabama and all of West Virginia. The Appalachian Regional Development Act Amendments of 1967 (PL 90-103) increased the total to 397 counties by the addition of two counties in Alabama, 20 in Mississippi, and one each in New York and Tennessee, but data have not been included for the 24 added counties because of time limitations. Figure 3 - 1 shows the 397 counties in the Appalachian Region as amended by PL 90-103 October 11, 1967.

The mineral industry is an important contributor to the overall economy of the Appalachian Region. In 1964, minerals and fuels valued at about $2 billion were produced in Appalachia. Of this

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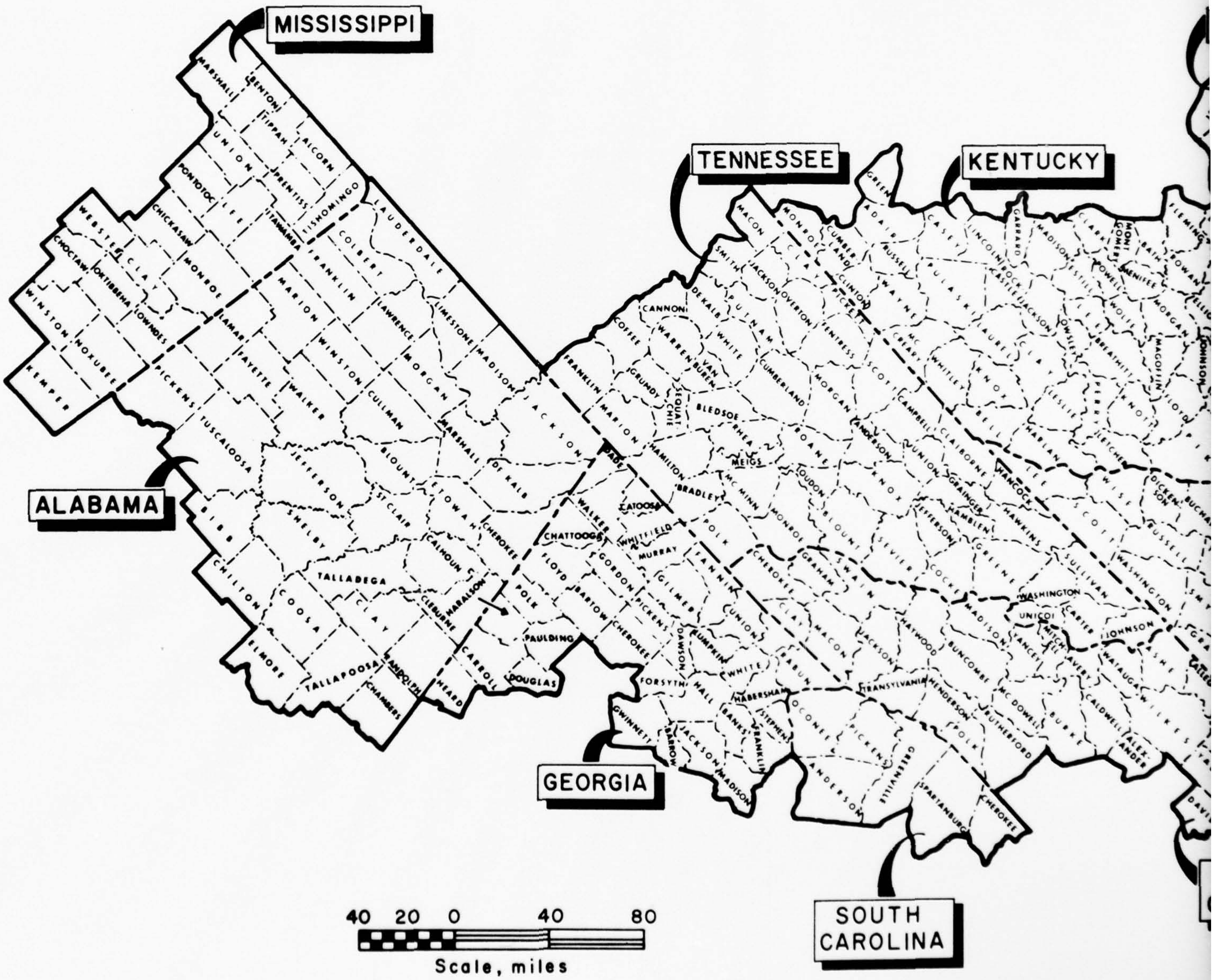

MISSISSIPPI
TENNESSEE
KENTUCKY
ALABAMA
GEORGIA
SOUTH CAROLINA
40 20 0 40 80
Scale, miles

FIGURE

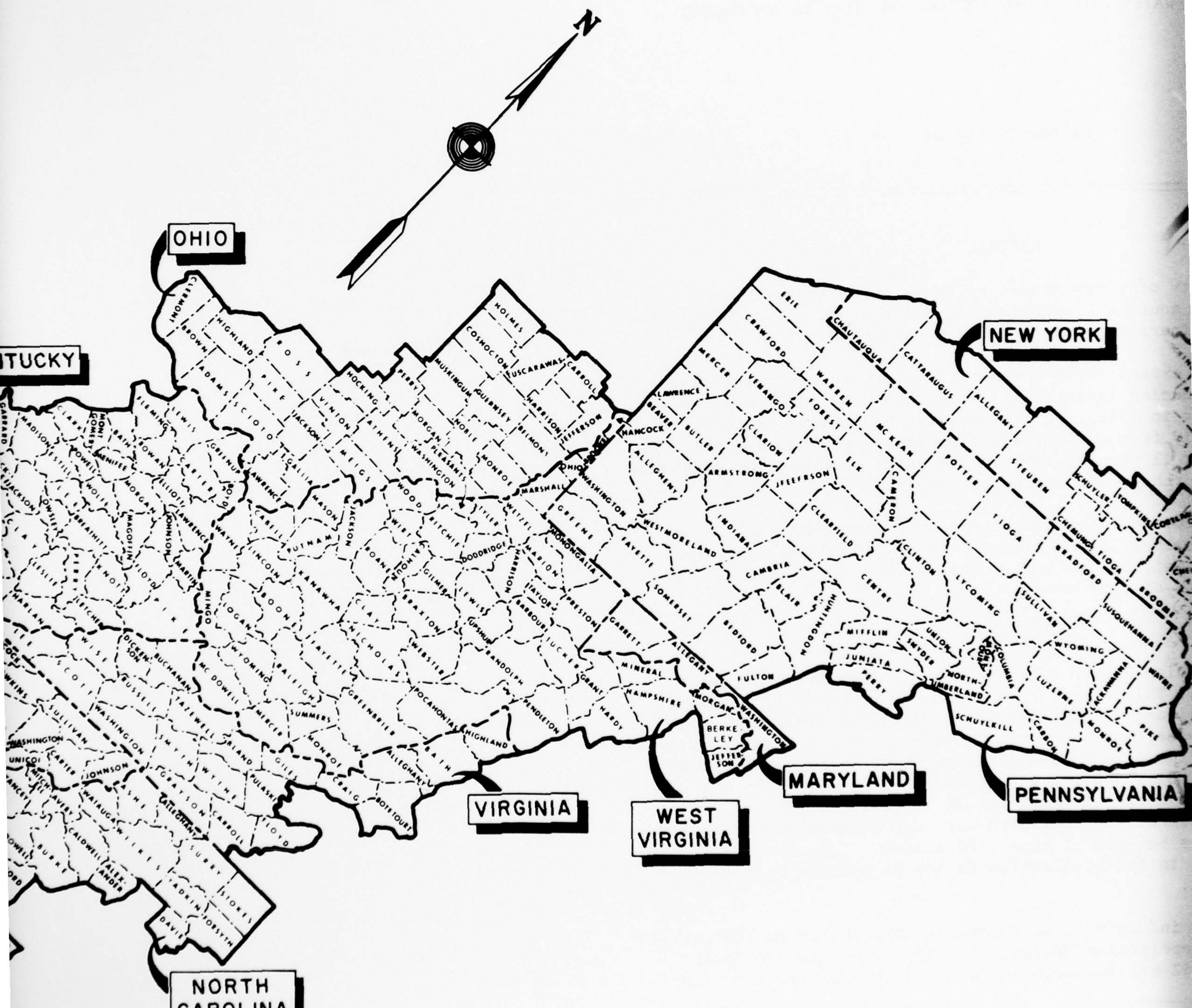
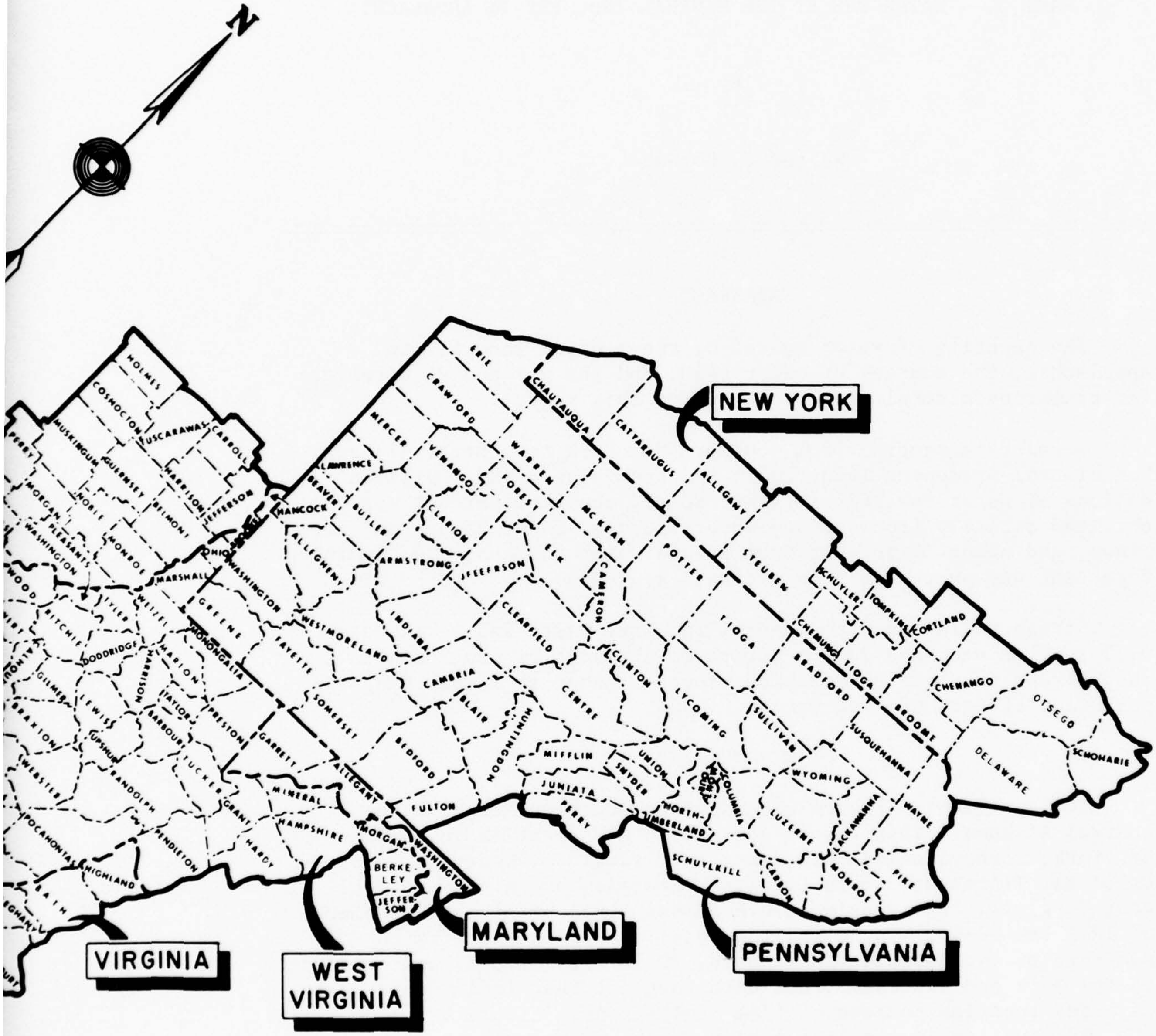


FIGURE 3 - 1. - Appalachia.


N
NEW YORK
MARYLAND
PENNSYLVANIA
VIRGINIA
WEST VIRGINIA
ERIE
CRAWFORD
CHAUTAUQUA
CATTARAUGUS
ALLEGANY
STEUBEN
MERCER
VENANGO
WARREN
FOREST
MC KEAN
POTTER
TIOGA
LAWRENCE
BEAVER
BUTLER
CLARION
ELK
CAMERON
ALLEGHENY
ARMSTRONG
JEFFERSON
CLEARFIELD
INDIANA
WESTMORELAND
WASHINGTON
GREENE
FAYETTE
SOMERSET
CAMBRIA
BLAIR
HUNTINGDON
BEDFORD
FULTON
CENTRE
CLINTON
LYCOMING
SULLIVAN
BRADFORD
CHEMUNG
SCHUYLER
TOMPKINS
CORTLAND
CHENANGO
BROOME
OTSEGO
SCHOHARIE
DELAWARE
SUSQUEHANNA
WYOMING
LACKAWANNA
WAYNE
LUZERNE
MONROE
PIKE
CARBON
SCHUYLKILL
COLUMBIA
NORTH-UMBERLAND
UNION
SNYDER
MIFFLIN
JUNIATA
PERRY
HOLMES
COSHOCTON
TUSCARAWAS
CARROLL
MUSKINGUM
GUERNSEY
HARRISON
JEFFERSON
MORGAN
NOBLE
BELMONT
MONROE
WASHINGTON
HANCOCK
OHIO
MARSHALL
TYLER
WETZEL
RITCHIE
DODDRIDGE
MARION
MONONGALIA
GILMER
LEWIS
HARRISON
TAYLOR
PRESTON
BARBOUR
BRAXTON
UPSHUR
TUCKER
WEBSTER
RANDOLPH
GRANT
MINERAL
HAMPSHIRE
HARDY
PENDLETON
POCAHONTAS
HIGHLAND
BATH
GARRETT
ALLEGANY
MORGAN
WASHINGTON
BERKELEY
JEFFERSON

total, bituminous coal accounted for about $1.6 billion, anthracite about $145 million, sand and gravel about $50 million, crushed and dimension stone about $150 million, and clay and shale and miscellaneous minerals about $76 million (table 3 - 1).

Statistical data and water requirements were adapted from U.S. Bureau of Mines records at Pittsburgh, Pa., and at Knoxville, Tenn.

Large quantities of water were used to wash much of the coal, sand and gravel, and stone produced. A secondary use was the mixing of water with clay and shales to mold ceramic products before firing. A small quantity of water was used by the mineral industries to control dust during mining or quarrying operations; also small quantities were used for sanitation and for miscellaneous equipment.

Water used by the mineral industry was obtained from four sources: (1) surface water, (2) ground water, (3) mine water, and (4) purchased water from external sources.

Mineral industries are often located in major stream valleys, and much of the water that is used is obtained from streams. The average flow from major rivers draining Appalachia is more than 150 billion gallons per day.

In general, the Appalachian Region is amply supplied with ground water. The largest water supplies are found in glacial outwash and river gravel deposits. The areas underlain with sandstone or certain limestone beds, that are fractured and contain solution channels are usually water productive. The poorer water sources are the shales, granites, gneisses, and other low-porosity rocks.

The mineral production in the Appalachian Region has been tabulated by State and county in table 3 - 2.

TABLE 3 - 1. - Appalachian mineral production, 1964[1/]

State and commodity	Quantity (thousand tons)	Value (thousand dollars)
New York:		
Sand and gravel...........	3,577	4,433
Crushed stone.............	(2/)	(2/)
Dimension stone...........	37	1,004
Clay......................	(2/)	(2/)
Pennsylvania:		
Bituminous coal...........	76,531	388,218
Anthracite................	16,246	145,169
Sand and gravel...........	10,649	18,092
Crushed stone.............	16,273	27,789
Dimension stone...........	44	946
Clay......................	2,398	12,503
Ohio:		
Bituminous coal...........	34,471	128,520
Sand and gravel...........	4,584	7,169
Crushed stone.............	4,656	7,944
Dimension stone...........	73	2,546
Clay......................	1,955	7,126
West Virginia:		
Bituminous coal...........	141,408	693,572
Sand and gravel...........	5,472	11,555
Crushed stone.............	7,481	13,105
Dimension stone...........	(2/)	(2/)
Clay......................	1,955	7,126
Maryland:		
Bituminous coal...........	1,136	4,511
Sand and gravel...........	295	790
Crushed stone.............	(2/)	(2/)
Dimension stone...........	(2/)	(2/)
Clay......................	162	192

1/ Excludes counties added to Appalachia by PL 90-103.
2/ Concealed to avoid disclosing individual company confidential data.

TABLE 3 - 1. - Appalachian mineral production, 1964 - Continued

State and commodity	Quantity (thousand tons)	Value (thousand dollars)
Virginia:		
Bituminous coal..........	31,646	123,094
Sand and gravel..........	208	366
Crushed stone............	8,801	14,222
Clay.....................	(2/)	(2/)
Kentucky:		
Bituminous coal..........	44,895	185,575
Sand and gravel..........	4	4
Crushed stone............	5,356	7,935
Clay.....................	229	905
Tennessee:		
Bituminous coal..........	5,990	22,673
Sand and gravel..........	1,682	2,656
Crushed stone............	17,451	23,912
Dimension stone..........	(2/)	(2/)
Clay.....................	612	420
Miscellaneous minerals...	112	34,638
North Carolina:		
Sand and gravel..........	2,733	2,615
Crushed stone............	3,634	5,465
Dimension stone..........	(2/)	(2/)
Clay.....................	(2/)	(2/)
Miscellaneous minerals...	307	2,866
South Carolina:		
Sand and gravel..........	169	208
Crushed stone............	3,373	4,667
Georgia:		
Bituminous coal..........	4	15
Sand and gravel..........	1	2
Crushed stone............	6,434	9,694
Dimension stone..........	(2/)	(2/)
Clay.....................	(2/)	(2/)
Miscellaneous minerals...	460	4,042

TABLE 3 - 1. - Appalachian mineral production, 1964 - Continued

State and commodity	Quantity (thousand tons)	Value (thousand dollars)
Alabama:		
Bituminous coal...........	14,435	102,267
Sand and gravel...........	1,679	1,968
Crushed stone.............	14,341	17,475
Clay......................	527	838
Miscellaneous minerals....	1,490	9,260
Undistributed:2/		
Crushed stone.............	2,410	3,240
Dimension stone...........	173	10,507
Clay......................	965	1,147

TABLE 3 - 2. - Minerals produced in Appalachia, by States and counties, in 1964 1/

State and county	Minerals produced in order of value
Alabama:	
Bibb	Coal, limestone.
Blount	Iron ore, cement, fire clay, limestone, coal.
Calhoun	Fire clay, limestone, miscellaneous clay, iron ore.
Cherokee	Sand and gravel, iron ore.
Chilton	Sand and gravel.
Cleburne	Do.
Colbert	Limestone, native asphalt.
Cullman	Limestone, coal.
De Kalb	Limestone.
Elmore	Sand and gravel.
Etowah	Limestone, coal, sand and gravel, fire clay.
Franklin	Iron ore, limestone, sand and gravel, fire clay.
Jackson	Coal, limestone.
Jefferson	Coal, cement, iron ore, limestone, miscellaneous clay, sandstone, fire clay.
Limestone	Limestone.
Madison	Limestone, miscellaneous clay.
Marion	Coal, kaolin.
Marshall	Limestone, sandstone.
Morgan	Limestone, sand and gravel.
Randolph	Mica.
St. Clair	Cement, limestone, fire clay, miscellaneous clay, coal.
Shelby	Cement, lime, limestone, coal, miscellaneous clay.
Talladega	Marble, limestone, talc, iron ore.
Tuscaloosa	Coal, iron ore, sand and gravel, limestone.
Walker	Coal, fire clay, miscellaneous clay.
Winston	Coal.
Georgia:	
Bartow	Barite, slate, limestone, iron ore, iron oxide pigments.
Chattoga	Marble.
Cherokee	Mica, sand and gravel.
Dade	Limestone.

1/ Excludes 24 counties added to Appalachia by PL 90-103 and 46 counties where no minerals were produced in 1964.

TABLE 3 - 2. - Minerals produced in Appalachia, by States and counties, in 1964 - Continued

State and county	Minerals produced in order of value
Georgia - Continued	
Douglas...........	Granite.
Fannin............	Limestone.
Floyd.............	Limestone, miscellaneous clay, bauxite, kaolin.
Forsyth...........	Granite.
Franklin..........	Sand and gravel.
Gilmer............	Marble.
Gordon............	Miscellaneous clay.
Gwinett...........	Granite, sand and gravel.
Hall..............	Granite.
Madison...........	Do.
Murray............	Talc, soapstone.
Pickens...........	Marble, sandstone.
Polk..............	Cement, slate, miscellaneous clay, iron ore, sandstone.
Rabun.............	Granite.
Walker............	Limestone, coal.
Whitfield.........	Limestone.
Kentucky:2/	
Adair.............	Limestone.
Bath..............	Petroleum.
Bell..............	Coal, petroleum.
Boyd..............	Coal, miscellaneous clay, petroleum.
Breathitt.........	Coal, petroleum.
Carter............	Limestone, fire clay, coal.
Casey.............	Limestone, petroleum.
Clay..............	Coal.
Clinton...........	Petroleum, limestone, coal.
Cumberland........	Petroleum, limestone.
Elliott...........	Petroleum, coal.
Estill............	Petroleum, limestone.
Fleming...........	Limestone.
Floyd.............	Coal, petroleum.
Garrard...........	Limestone.
Green.............	Petroleum, limestone.
Greenup...........	Fire clay, petroleum.

2/ Other than natural gas and natural gas liquids.

TABLE 3 - 2. - Minerals produced in Appalachia, by States and counties, in 1964 - Continued

State and county	Minerals produced in order of value
Kentucky - Continued	
Harlan............	Coal, limestone.
Jackson...........	Coal, limestone, petroleum.
Johnson...........	Petroleum, coal.
Knott.............	Coal, petroleum.
Knox..............	Do.
Laurel............	Coal, limestone, petroleum.
Lawrence..........	Petroleum, coal.
Lee...............	Petroleum, limestone, coal.
Leslie............	Coal, petroleum.
Letcher...........	Coal, limestone, petroleum.
Lincoln...........	Petroleum.
McCreary..........	Coal, petroleum.
Madison...........	Limestone.
Magoffin..........	Petroleum, coal.
Martin............	Coal, petroleum.
Menifee...........	Limestone, petroleum.
Monroe............	Do.
Montgomery........	Limestone.
Morgan............	Limestone, coal, petroleum.
Owsley............	Coal, petroleum.
Perry.............	Do.
Pike..............	Coal, petroleum, limestone, sand and gravel.
Powell............	Petroleum, limestone, miscellaneous clay.
Pulaski...........	Limestone, coal.
Rockcastle........	Do.
Rowan.............	Fire clay, limestone, miscellaneous clay.
Russell...........	Petroleum.
Wayne.............	Coal, limestone, petroleum.
Whitley...........	Coal, petroleum, miscellaneous clay.
Wolfe.............	Petroleum, coal.
Maryland:	
Allegany..........	Coal, sand and gravel, stone, clays.
Garrett...........	Coal, natural gas, stone, sand and gravel, peat.
Washington........	Cement, stone, clays, potassium, salts.

TABLE 3 - 2. - Minerals produced in Appalachia, by States and counties, in 1964 - Continued

State and county	Minerals produced in order of value
New York:[3]	
Allegany.............	Sand and gravel.
Broome...............	Sand and gravel, stone, clays.
Cattaraugus..........	Sand and gravel, peat.
Chatauqua............	Sand and gravel.
Chemung..............	Do.
Chenango.............	Do.
Cortland.............	Do.
Delaware.............	Stone, sand and gravel.
Otsego...............	Do.
Schuyler.............	Salt, sand and gravel.
Steuben..............	Sand and gravel.
Tioga................	Do.
Tompkins.............	Salt, stone, sand and gravel.
North Carolina:	
Alexander............	Sand and gravel.
Ashe.................	Do.
Avery................	Kaolin, mica, sand and gravel.
Buncombe.............	Sand and gravel, granite.
Burke................	Sand and gravel.
Caldwell.............	Granite, sand and gravel.
Cherokee.............	Marble, granite, talc, sand and gravel.
Davie................	Sand and gravel.
Forsyth..............	Granite, sand and gravel.
Haywood..............	Sand and gravel.
Henderson............	Limestone, granite, miscellaneous clay.
Jackson..............	Olivine, granite.
McDowell.............	Sand and gravel, feldspar.
Macon................	Granite, sand and gravel.
Madison..............	Sand and gravel, feldspar.
Mitchell.............	Feldspar, mica, sandstone, sand and gravel.
Polk.................	Granite, sand and gravel.
Rutherford...........	Sand and gravel.
Stokes...............	Miscellaneous clay, sand and gravel.
Surry................	Granite, traprock, sand and gravel.
Swain................	Limestone, granite.
Watauga..............	Sand and gravel, granite.
Wilkes...............	Granite, sand and gravel.
Yadkin...............	Do.
Yancey...............	Mica, olivine, sand and gravel, feldspar.

3/ Other than petroleum and natural gas.

TABLE 3 - 2. - Minerals produced in Appalachia, by States and counties, in 1964 - Continued

State and county	Minerals produced in order of value
Ohio:	
Adams...............	Stone.
Athens..............	Coal, stone, clays, sand and gravel.
Belmont.............	Coal, stone.
Brown...............	Stone, sand and gravel.
Carroll.............	Coal, clays, sand and gravel, stone.
Coshocton...........	Coal, stone, sand and gravel.
Gallia..............	Coal, stone, sand and gravel, clays.
Guernsey............	Coal, stone.
Harrison............	Coal, stone, clays.
Highland............	Stone, sand and gravel, clays.
Hocking.............	Coal, clays.
Holmes..............	Coal, stone, clays, sand and gravel.
Jackson.............	Coal, clays, stone.
Jefferson...........	Coal, clays.
Lawrence............	Cement, stone, coal, clays, sand and gravel.
Meigs...............	Coal, sand and gravel, salt.
Monroe..............	Sand and gravel, stone.
Morgan..............	Coal, stone, sand and gravel.
Muskingum...........	Cement, stone, coal, sand and gravel, clays.
Noble...............	Coal, stone, clays.
Perry...............	Coal, sand and gravel, clays, stone.
Pike................	Sand and gravel, stone.
Ross................	Do.
Scioto..............	Stone, clays, sand and gravel.
Tuscarawas..........	Coal, clays, sand and gravel, stone.
Vinton..............	Coal, stone.
Washington..........	Sand and gravel, abrasives.
Pennsylvania:[4/]	
Allegheny...........	Coal, cement, clays, sand and gravel, stone, iron ore (pigment material).
Armstrong...........	Coal, clays, sand and gravel, stone, lime.
Beaver..............	Coal, sand and gravel, clays.
Bedford.............	Stone, coal, lime.
Blair...............	Stone, coal, clays, sand and gravel.
Bradford............	Sand and gravel, coal.
Butler..............	Coal, cement, stone, lime, sand and gravel, clays.

4/ Other than petroleum, natural gas, and natural gas liquids.

TABLE 3 - 2. - Minerals produced in Appalachia, by States and counties, in 1964 - Continued

State and county	Minerals produced in order of value
Pennsylvania - Continued	
Cambria................	Coal, clays, stone, sand and gravel, iron ore (pigment material).
Cameron................	Coal.
Carbon.................	Coal, stone, sand and gravel.
Centre.................	Lime, stone, coal, clays.
Clarion................	Coal, stone, clays, sand and gravel.
Clearfield.............	Coal, clays, sand and gravel.
Clinton................	Coal, clays, stone, sand and gravel.
Columbia...............	Coal, sand and gravel, clays, peat.
Crawford...............	Sand and gravel.
Elk....................	Coal, sand and gravel, stone.
Erie...................	Sand and gravel, peat.
Fayette................	Coal, stone, clays, sand and gravel.
Forest.................	Sand and gravel.
Fulton.................	Stone, sand and gravel.
Greene.................	Coal, clays.
Huntingdon.............	Sand and gravel, stone, coal, clays.
Indiana................	Coal, clays.
Jefferson..............	Coal, clays, stone, sand and gravel.
Juniata................	Stone, lime.
Lackawanna.............	Coal, sand and gravel, stone, peat.
Lawrence...............	Cement, stone, coal, clays, sand and gravel, peat.
Luzerne................	Coal, sand and gravel, stone, peat, clays.
Lycoming...............	Stone, sand and gravel, coal, tripoli.
McKean.................	Clays, coal, stone, sand and gravel.
Mercer.................	Coal, sand and gravel, stone.
Mifflin................	Sand and gravel, stone, lime.
Monroe.................	Stone, sand and gravel, clays.
Montour................	Stone, sand and gravel.
Northumberland.........	Coal, clays, stone, lime.
Perry.................	Stone.
Potter.................	Do.
Schuylkill.............	Coal, stone, sand and gravel, clays.
Snyder.................	Sand and gravel, stone, coal, lime.
Somerset...............	Coal, clays, stone, sand and gravel.
Sullivan...............	Coal.
Susquehanna............	Stone.
Tioga..................	Coal, sand and gravel, stone.

TABLE 3 - 2. - Minerals produced in Appalachia, by States and counties, in 1964 - Continued

State and county	Minerals produced in order of value
Pennsylvania - Continued	
Union	Stone.
Venango	Coal, sand and gravel.
Warren	Sand and gravel.
Washington	Coal, stone.
Wayne	Stone, sand and gravel, peat, coal.
Westmoreland	Coal, sand and gravel, stone, lime.
Wyoming	Sand and gravel, stone.
South Carolina:	
Anderson	Granite.
Cherokee	Limestone, sand and gravel, barite, miscellaneous clays.
Greenville	Granite, sand and gravel.
Pickens	Do.
Spartanburg	Granite, feldspar, sand and gravel.
Tennessee:[3/]	
Anderson	Coal, limestone, miscellaneous clay.
Bledsoe	Coal.
Blount	Marble, limestone.
Bradley	Limestone, sand and gravel.
Campbell	Coal, limestone, sandstone.
Carter	Limestone.
Claiborne	Coal, limestone.
Clay	Limestone.
Cocke	Do.
Coffee	Do.
Cumberland	Sandstone, limestone, sand and gravel, coal.
Fentress	Limestone, coal, sandstone.
Franklin	Cement, limestone, sandstone, sand and gravel, miscellaneous clay.
Grainger	Marble.
Greene	Limestone, sand and gravel.
Grundy	Coal, sand and gravel, limestone.
Hamblen	Limestone.
Hamilton	Cement, limestone, sand and gravel, coal, miscellaneous clay.
Hancock	Zinc, limestone.

3/ Other than petroleum and natural gas.

TABLE 3 - 2. - Minerals produced in Appalachia, by States and counties, in 1964 - Continued

State and county	Minerals produced in order of value
Tennessee - Continued	
Hawkins	Limestone.
Jefferson	Zinc, limestone.
Johnson	Limestone.
Knox	Cement, zinc, limestone, marble, lime, sand and gravel, miscellaneous clay.
Loudon	Barite, sand and gravel, miscellaneous clay.
McMinn	Barite, limestone.
Macon	Limestone.
Marion	Cement, coal, limestone.
Meigs	Limestone.
Monroe	Limestone, sand and gravel, barite.
Morgan	Coal.
Overton	Limestone, coal.
Polk	Copper, pyrites, zinc, silver, sand and gravel, gold.
Putnam	Coal, limestone, sand and gravel.
Rhea	Limestone, coal.
Roane	Limestone.
Scott	Coal.
Sequatchie	Limestone, coal.
Sevier	Limestone, sand and gravel.
Sullivan	Cement, limestone, miscellaneous clay.
Unicoi	Sand and gravel, limestone.
Union	Marble, limestone.
Van Buren	Coal.
Warren	Limestone.
Washington	Limestone, miscellaneous clay.
White	Limestone.
Virginia:	
Alleghany	Stone.
Bland	Do.
Botetourt	Cement, stone, clays.
Buchanan	Coal, natural gas.
Craig	Sand and gravel.
Dickenson	Coal, natural gas, sand and gravel.
Giles	Lime, stone.
Grayson	Stone.
Highland	Do.
Lee	Coal, stone, petroleum.
Pulaski	Stone, iron ore (pigment material).
Russell	Coal, stone, clays.

TABLE 3 - 2. - Minerals produced in Appalachia, by States and counties, in 1964 - Continued

State and county	Minerals produced in order of value
Virginia - Continued	
Scott..............	Stone, coal.
Smyth..............	Lime, salt, stone, sand and gravel, clays.
Tazewell...........	Stone, coal, lime, clays, natural gas.
Washington.........	Stone, gypsum, sand and gravel.
Wise...............	Coal, stone, sand and gravel.
Wythe..............	Zinc, stone, lead, sand and gravel.
West Virginia:[4/]	
Barbour............	Coal.
Berkeley...........	Cement, stone, lime, clays.
Boone..............	Coal.
Braxton............	Coal, stone.
Brooke.............	Coal, sand and gravel.
Cabell.............	Sand and gravel, clays.
Clay...............	Coal.
Doddridge..........	Stone.
Fayette............	Coal.
Gilmer.............	Do.
Grant..............	Coal, stone.
Greenbrier.........	Do.
Hancock............	Clays, sand and gravel, coal.
Hardy..............	Stone.
Harrison...........	Coal, stone.
Jefferson..........	Stone, lime.
Kanawha............	Coal, salt, clays, stone, calcium-magnesium chloride.
Lewis..............	Coal, stone, clays.
Lincoln............	Coal, sand and gravel.
Logan..............	Coal.
McDowell...........	Do.
Marion.............	Do.
Marshall...........	Coal, salt.
Mason..............	Coal, sand and gravel.
Mercer.............	Coal, stone, clays.
Mineral............	Stone, coal.
Mingo..............	Coal.
Monongalia.........	Coal, stone, sand and gravel.
Morgan.............	Sand and gravel.
Nicholas...........	Coal, stone.
Ohio...............	Coal, sand and gravel.
Pendleton..........	Stone.
Pleasants..........	Salt.

TABLE 3 - 2. - Minerals produced in Appalachia, by States and counties, in 1964 - Continued

State and county	Minerals produced in order of value
West Virginia - Continued	
Pocahontas..........	Coal, stone, sand and gravel.
Preston.............	Coal, stone.
Putnam..............	Coal.
Raleigh.............	Coal, stone, sand and gravel.
Randolph............	Coal, stone.
Taylor..............	Coal, clays.
Tucker..............	Coal, stone, sand and gravel.
Tyler...............	Sand and gravel, salt.
Upshur..............	Coal, stone.
Wayne...............	Coal.
Webster.............	Do.
Wetzel..............	Sand and gravel.
Wood................	Do.
Wyoming.............	Coal, sand and gravel.

ANTHRACITE

Anthracite and semianthracite occur in northeastern Pennsylvania in four geographically separated and geologically distinct deposits; the Northern, Eastern Middle, Western Middle, and Southern fields.

The 1962 production from mines in the Appalachian Region was 97 percent of the national output; production for 1964 was 95 percent of the U.S. total.

Coal Preparation

Early methods of preparing anthracite consisted of dry screening and "hand-picking" to remove the undesirable parts of run-of-mine coal. The dry methods of preparation were gradually superseded by wet methods. Wet methods began with the use of jigs of various designs and progressed to heavy-media separation. The usual cleaning devices reject about 10 to 50 percent of the raw coal feed. The rejects are usually stored on mine property in "waste," "refuse," "culm," or "slush" banks or piles.

The anthracite produced in Appalachia is washed or prepared in 100 or more plants located near various mining operations. In 1962, an average of 1,880 gallons of water was used to prepare each ton shipped (table 3 - 3).

The sources of water were (1) mines, (2) streams, (3) external systems, and (4) wells. The percentages of water from each source in 1962 were 64, 31, 4, and 1 respectively.

Based on a previous Bureau of Mines report,[2/] projected anthracite production is about 6 million tons in 1970, 3 million tons in 1985, and 2.5 million tons in 2020; the corresponding water requirements would be about 11 billion, 5.6 billion, and 4.7 billion gallons of water, respectively. Water use estimates were based on an average of 1,880 gallons of water needed to prepare a ton of anthracite.

Other Water Uses

Small quantities of water were used inside underground anthracite mines for dust control. The overall dust problem in anthracite mines was not as serious as that inside bituminous coal mines; therefore, less water was used for dust control in the anthracite mines.

2/ Wessel, F. William, Donald J. Frendzel, and Gabriel F. Cazell. Mineral Industry Economics in the Susquehanna River Basin. U.S. Bureau of Mines in cooperation with Baltimore District Engineers, U.S. Army Corps of Engineers, 1964, 90 pp.

TABLE 3 - 3. - Water requirements for preparation of anthracite in the Appalachian region of Pennsylvania
(All figures are for 1962 unless otherwise specified)

County	Anthracite production			Water use (million gallons)							Gallons of water per ton of product 2/	Water treatment methods 3/	Water disposal (million gallons)		1964 anthracite production	
				Intake water by source					Recircu-lating	Total						
	Quantity (1,000 tons)	Value ($1,000)	Washed (1,000 tons)	Purchased	Wells	Mine 1/	Stream 1/	Total					Consumed 4/	To settling ponds, streams, or mines	Quantity (1,000 tons)	Value ($1,000)
Carbon.........	674	5,496	674	-	-	510	511	1,021	126	1,147	1,700	Settle, neutralize.	102	919	501	4,428
Columbia.......	388	2,547	(5/)	(5/)	-	(5/)	-	(5/)	(5/)	(5/)	(5/)	Settle......	(5/)	(5/)	823	7,582
Lackawanna.....	1,103	10,532	6/1,435	91	-	119	2,160	2,370	124	2,494	1,740	Settle, neutralize.	237	2,133	920	9,290
Luzerne........	6,061	50,978	6,061	320	4	3,319	819	4,462	6,084	10,546	1,740	.....do.....	446	4,016	6,036	56,792
Northumberland.	1,625	12,253	1,625	67	47	974	247	1,335	452	1,787	1,100	.....do.....	135	1,200	2,146	16,515
Schuylkill.....	6,203	49,242	6,203	187	74	4,470	853	5,584	8,248	13,832	2,230	.....do.....	564	5,020	5,802	50,464
Sullivan.......	12	63	12	-	2	7	-	9	3	12	1,000	.....do.....	1	8	16	82
Susquehanna....	(5/)	(5/)	(5/)	(5/)	(5/)	(5/)	-	(5/)	(5/)	(5/)	(5/)	Settle......	(5/)	(5/)	-	-
Wayne..........	(5/)	(5/)	(5/)	(5/)	(5/)	(5/)	-	(5/)	(5/)	(5/)	(5/)	.....do.....	(5/)	(5/)	2	16
Undistributed..	11	86	399	6	3	226	-	235	729	964	2,420	Settle, neutralize.	25	210	-	-
Total or average.....	16,077	131,197	6/16,409	671	130	9,625	4,590	15,016	15,766	30,782	1,880		1,510	13,506	16,246	145,169

1/ Water, if acid, is usually neutralized before use.
2/ Water requirements calculated to nearest 10 gallons.
3/ Intake water, before use, is usually pumped to recirculating pond or tank.
4/ Water lost by evaporation or retained in the washed product.
5/ Included in "Undistributed" to avoid disclosing individual operations.
6/ Includes anthracite produced outside Appalachia but washed in Appalachia, reworked culm piles, and units of production less than 1,000 tons per year which are not reported to the Bureau of Mines.

Water Quality

The anthracite industry has no formal specifications or standards for water quality, either for wash water for coal preparation or for spray water to control dust inside a mine. Limiting conditions exist for the water for efficient plant or equipment operation. Therefore, the water must be (1) free of floating solids, (2) relatively free of suspended solids, and (3) about neutral within a pH range of 5 to 7.

Floating solids must be held to a minimum to prevent plugging of the circulating systems and the spray nozzles, both in the preparation plant and on underground mining equipment. Suspended solids should not exceed 5 weight-percent to prevent solids buildup, which may change the gravity of the washing medium, thus affecting coal-cleaning results. Acid water should be neutralized, usually with lime, to minimize acid corrosion of equipment.

BITUMINOUS COAL

Mining bituminous coal is a major industry in Appalachia. Many Appalachian communities depend almost entirely upon the earnings of men employed by the coal industry in their localities. The loss of traditional coal markets and technological changes in the industry resulted in less employment and many of the region's economic difficulties.

The 1962 bituminous coal production in Appalachia was more than 300 million tons, valued at more than $1.4 billion and representing 71 percent of the U.S. total for that year. The 1964 production was more than 350 million tons, valued at more than $1.6 billion and accounting for 72 percent of the U.S. total (table 3 - 4).

The youngest bituminous coalbeds of Appalachia are in the Dunkard Group in southwest Pennsylvania and northern West Virginia; the oldest are in the Pottsville Formation in southern Appalachia from West Virginia to Alabama. The Pocahontas coalbeds in the Pottsville Formation, in southern West Virginia and Virginia, are the most famous. The Pittsburgh coalbeds in the Monongahela Formation of northern West Virginia, Pennsylvania, and Ohio have been considered one of the most valuable mineral deposits in the world.

Coal Preparation

The preparation of bituminous coal began with discarding the small sizes and other undesirables and hand-loading lump coal inside the mine. This procedure was followed by picking tables and other dry cleaning methods outside the mine. A gradual change has been continuing from dry to wet cleaning methods. By the end of 1962, about 54 percent of the total bituminous coal production in Appalachia was washed in preparation for the market. The average quantity of water used to wash bituminous coal in Appalachia in 1962

TABLE 3 - 4. - Water requirements for preparation of bituminous coal in Appalachia

(All figures are for 1962 unless otherwise specified)

State	Bituminous coal production			Water use (million gallons)							Gallons of water per ton of product 2/	Water treatment methods 3/	Water disposal (million gallons)		1964 bituminous coal production	
	Quantity (1,000 tons)	Value ($1,000)	Washed (1,000 tons)	Intake water by source					Recircu-lating	Total			Consumed 4/	To settling ponds, streams, or mines	Quantity (1,000 tons)	Value ($1,000)
				Purchased	Wells	Mine 1/	Stream 1/	Total								
Pennsylvania...	65,315	331,298	32,847	381	122	276	1,905	2,684	23,512	26,196	800	Settle, neutralize, filter.....	262	2,422	76,531	388,218
Ohio..........	31,142	116,679	12,613	1	2	116	518	637	7,834	8,471	670	Settle......	287	350	34,471	128,520
West Virginia..	118,499	578,293	80,720	113	903	2,219	3,929	7,164	42,025	49,189	610	Settle, neutralize, filter.....	2,029	5,135	141,408	693,572
Virginia.......	29,463	117,518	11,915	-	122	307	1,210	1,639	8,247	9,886	830	Settle......	285	1,354	31,646	123,094
Alabama........	12,881	95,149	10,185	43	27	-	2,259	2,329	7,367	9,696	950	.....do.....	241	2,088	14,435	102,267
Georgia........	8	28	-	-	-	-	-	-	-	-	-	-	-	-	4	15
Tennessee......	6,214	22,555	-	-	-	-	-	-	-	-	-	-	-	-	5,990	22,673
Kentucky.......	37,155	162,596	13,582	18	507	-	505	1,030	9,760	10,790	790	Settle......	107	923	44,895	185,575
Maryland.......	821	3,168	-	-	-	-	-	-	-	-	-	-	-	-	1,136	4,511
Total or average 5/...	301,498	1,427,284	161,862	556	1,683	2,918	10,326	15,483	98,745	114,228	710		3,211	12,272	350,516	1,648,445

1/ Water, if acid, is usually neutralized before use.
2/ Water requirements calculated to nearest 10 gallons.
3/ Intake water, before use, is usually pumped to recirculating pond or tank.
4/ Water lost by evaporation or retained in the washed product.
5/ Excludes counties added to Appalachia by PL 90-103.

was 710 gallons per ton of coal. The sources of intake water used to wash the coal were (1) streams - 68 percent, (2) mines - 20 percent, (3) wells - 8 percent, and (4) purchases - 4 percent (table 3 - 4).

Other Water Uses

Water was used in bituminous coal mines to control dust in underground mines. Water use included the following:

1. Spray nozzles on continuous miners and coal cutting machines which apply as much as 450 gallons of water per hour to the coal face at the cutters.

2. Sprays for coal loaders applying water at a rate of about 380 gallons per hour to the mined coal as it is removed from the mine floor.

3. Spray nozzles at conveyor loading chutes inside the mine and at conveyor discharge points both inside and outside the mine. Water was sprayed at a rate of about 100 gallons per hour at each coal handling location along the conveyor belts.

4. Water was sprayed along haulageways inside mines to control dust. The rate of water use depends upon length of dusty haulageways and was sprayed at a rate up to 500 gallons per hour.

5. Water was used in cooling systems for continuous miners, coal loaders, coal cutting machines, trucks, tractors, and other equipment.

Water Quality

The bituminous coal industry has no formal specifications or standards for water quality either for wash water used in coal preparation plants or for spray water used for dust control. Limiting conditions exist for water for efficient plant or equipment operations. Therefore, the water used must be -

1. Free of floating solids.

2. Relatively free of suspended solids.

3. About neutral, with a pH of 5 to 7.

Floating solids must be held to a minimum to prevent plugging of the circulating systems and the spray nozzles, both in the preparation plant and in the mine. Suspended solids should not exceed 5 weight-percent to prevent a solids buildup which may change the gravity of the washing medium, thus affecting coal-cleaning results. Acid water should be neutralized, usually with lime, to minimize acid corrosion of equipment, both in the preparation plant and in the mine.

Pennsylvania

The bituminous coalbeds in Pennsylvania are in the Dunkard Group and the Monongahela, Conemaugh, Allegheny, and Pottsville Formations. The most important formations, as far as total coal production is concerned, are in the Monongahela and the Allegheny Formations.

The 1962 bituminous coal production in Pennsylvania, more than 65 million tons valued at more than $331 million, was about 22 percent of the Appalachia total for that year. The 1964 production was also about 22 percent of the Appalachia total for that year (tables 3 - 4 and 3 - 5).

In 1962, about 50 percent of the bituminous coal produced in Pennsylvania was washed. The average quantity of water used was 800 gallons per ton. The sources of intake water were (1) streams - 71 percent, (2) purchases - 14 percent, (3) mines - 10 percent, and (4) wells - 5 percent (tables 3 - 4 and 3 - 5).

Ohio

The bituminous coalbeds in Ohio are in the Dunkard Group and the Monongahela, Conemaugh, Allegheny, and Pottsville Formations. The most important formations, as far as total coal production is concerned, are in the Monongahela and the Allegheny Formations.

The 1962 Appalachian coal production in Ohio, more than 31 million tons valued at more than $116 million, was about 10 percent of the Appalachia total for that year. The 1964 production, more than 34 million tons valued at about $129 million, was also about 10 percent of the Appalachia total for that year.

In 1962, about 41 percent of the bituminous coal produced in Ohio was washed. The average quantity of water used was 670 gallons per ton. The sources of intake water were (1) streams - 82 percent, (2) mines - 18 percent, (3) wells - negligible, and (4) purchases - negligible (tables 3 - 4 and 3 - 6).

West Virginia

The bituminous coalbeds in West Virginia are in the Dunkard Group and the Monongahela, Conemaugh, Allegheny, and Pottsville Formations. The most important formations, as far as total coal production is concerned, are in the Monongahela, Allegheny, and Pottsville Formations.

The 1962 bituminous coal production in West Virginia, more than 118 million tons valued at more than $578 million, was more than 39 percent of the Appalachia total for that year. The 1964 production, more than 141 million tons valued at about $694 million, was about 40 percent of the Appalachia total for that year.

TABLE 3 - 5. - Water requirements for preparation of bituminous coal in the Appalachian region of Pennsylvania
(All figures are for 1962 unless otherwise specified)

County	Bituminous coal production			Water use (million gallons)							Gallons of water per ton of product 2/	Water treatment methods 3/	Water disposal (million gallons)		1964 bituminous coal production	
	Quantity (1,000 tons)	Value ($1,000)	Washed (1,000 tons)	Intake water by source					Recircu-lating	Total			Consumed 4/	To settling ponds, streams, or mines	Quantity (1,000 tons)	Value ($1,000)
				Purchased	Wells	Mine 1/	Stream 1/	Total								
Allegheny......	4,843	27,946	5,229	138	32	56	110	336	5,656	5,992	1,150	Settle, filter.....	34	302	4,832	26,170
Armstrong......	3,524	16,041	985	-	4	2	147	153	334	487	500	Settle, filter, neutralize.	15	138	4,320	18,280
Beaver.........	634	2,062	-	-	-	-	-	-	-	-	-	-	-	-	494	1,685
Bedford........	354	1,242	-	-	-	-	-	-	-	-	-	-	-	-	285	994
Blair..........	78	320	-	-	-	-	-	-	-	-	-	-	-	-	11	54
Bradford.......	(5/)	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Butler.........	2,227	7,973	414	-	1	-	24	25	74	99	240	Settle......	3	22	1,827	6,745
Cambria........	5,885	34,225	1,499	54	16	21	51	142	1,372	1,514	1,010	Settle, filter.....	14	128	8,741	48,202
Cameron........	(5/)	(5/)	(5/)	-	-	-	(5/)	(5/)	(5/)	(5/)	(5/)	Settle......	(5/)	(5/)	(5/)	(5/)
Centre.........	729	2,765	-	-	-	-	-	-	-	-	-	-	-	-	601	2,199
Clarion........	3,492	12,159	1,672	-	12	-	29	41	324	365	220	Settle, neutralize.	4	37	3,174	11,052
Clearfield.....	6,601	24,569	475	-	2	-	38	40	123	163	340	Settle......	4	36	7,288	26,681
Clinton........	407	1,513	(5/)	-	-	-	(5/)	(5/)	(5/)	(5/)	(5/)	.....do.....	(5/)	(5/)	482	1,695
Elk............	457	1,686	-	-	-	-	-	-	-	-	-	-	-	-	440	1,530
Fayette........	1,293	6,088	3,672	12	1	-	217	230	1,520	1,750	480	Settle, filter, neutralize.	23	207	1,834	10,562
Greene.........	9,128	57,030	6,432	3	5	49	489	546	5,924	6,470	1,010	.....do.....	56	490	11,588	71,620
Huntingdon.....	30	123	-	-	-	-	-	-	-	-	-	-	-	-	68	223
Indiana........	4,822	23,388	(5/)	(5/)	(5/)	(5/)	(5/)	(5/)	(5/)	(5/)	(5/)	Settle......	(5/)	(5/)	5,509	24,657
Jefferson......	1,382	4,791	(5/)	-	-	(5/)	-	(5/)	(5/)	(5/)	(5/)	.....do.....	(5/)	(5/)	1,891	6,683
Lawrence.......	651	2,000	-	-	-	-	-	-	-	-	-	-	-	-	841	2,529
Lycoming.......	39	125	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
McKean.........	-	-	-	-	-	-	-	-	-	-	-	-	-	-	22	78
Mercer.........	1,125	4,244	-	-	-	-	-	-	-	-	-	-	-	-	587	2,271
Somerset.......	2,410	9,599	61	-	-	3	-	3	11	14	230	Settle......	1	2	3,168	14,184
Tioga..........	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Venango........	295	935	-	-	-	-	-	-	-	-	-	-	-	-	491	1,977
Washington.....	10,926	69,790	6,467	161	21	3	269	454	2,310	2,764	430	Settle, filter, neutralize.	44	410	13,460	85,064
Westmoreland...	3,570	18,971	2,318	9	23	56	95	183	1,037	1,220	530	.....do.....	13	170	4,081	20,971
Undistributed..	413	1,713	3,623	4	5	86	436	531	4,827	5,358	150	.....do.....	51	480	496	2,112
Total or average.....	65,315	331,298	32,847	381	122	276	1,905	2,684	23,512	26,196	800		262	2,422	76,531	388,218

1/ Water, if acid, is usually neutralized before use.
2/ Water requirements calculated to nearest 10 gallons.
3/ Intake water, before use, is usually pumped to recirculating pond or tank.
4/ Water lost by evaporation or retained in the washed product.
5/ Included in "Undistributed" to avoid disclosing individual operations.

TABLE 3 - 6. - Water requirements for preparation of bituminous coal in the Appalachian region of Ohio
(All figures are for 1962 unless otherwise specified)

County	Bituminous coal production			Water use (million gallons)							Gallons of water per ton of product 2/	Water treatment methods 3/	Water disposal (million gallons)		1964 bituminous coal production	
	Quantity (1,000 tons)	Value ($1,000)	Washed (1,000 tons)	Intake water by source					Recirculating	Total			Consumed 4/	To settling ponds, streams, or mines	Quantity (1,000 tons)	Value ($1,000)
				Purchased	Wells	Mine 1/	Stream 1/	Total								
Athens........	244	1,146	-	-	-	-	-	-	-	-	-	-	-	-	147	577
Belmont........	6,613	27,040	(5/)	(5/)	(5/)	-	-	(5/)	(5/)	(5/)	(5/)	Settle......	(5/)	(5/)	7,835	31,688
Carroll........	353	1,183	-	-	-	-	-	-	-	-	-	-	-	-	272	915
Coshocton......	1,816	7,566	-	-	-	-	-	-	-	-	-	-	-	-	2,302	9,481
Gallia.........	760	2,491	-	-	-	-	-	-	-	-	-	-	-	-	615	1,855
Guernsey.......	278	946	(5/)	-	-	-	(5/)	(5/)	(5/)	(5/)	(5/)	Settle......	(5/)	(5/)	308	1,033
Harrison.......	7,826	31,591	4,007	-	-	48	134	182	3,138	3,320	830	.....do.....	147	35	7,663	31,273
Hocking........	68	280	-	-	-	-	-	-	-	-	-	-	-	-	79	260
Holmes.........	243	783	-	-	-	-	-	-	-	-	-	-	-	-	205	623
Jackson........	301	1,200	(5/)	-	-	(5/)	(5/)	(5/)	(5/)	(5/)	(5/)	Settle......	(5/)	(5/)	563	1,946
Jefferson......	3,290	11,422	(5/)	-	-	-	(5/)	(5/)	(5/)	(5/)	(5/)	.....do.....	(5/)	(5/)	4,308	15,571
Lawrence.......	383	1,440	(5/)	-	-	(5/)	-	(5/)	(5/)	(5/)	(5/)	.....do.....	(5/)	(5/)	(5/)	(5/)
Meigs..........	258	737	-	-	-	-	-	-	-	-	-	-	-	-	406	1,145
Morgan.........	2,223	7,058	2,205	-	-	-	115	115	878	993	2,200	Settle......	80	35	1,870	5,589
Muskingum......	274	839	-	-	-	-	-	-	-	-	-	-	-	-	116	496
Noble..........	1,411	3,762	849	-	-	-	2	2	2	4	850	Settle......	1	1	2,722	8,148
Perry..........	(5/)	(5/)	(5/)	(5/)	(5/)	-	(5/)	(5/)	(5/)	(5/)	(5/)	.....do.....	(5/)	(5/)	(5/)	(5/)
Tuscarawas.....	2,442	8,629	299	-	-	-	28	28	349	377	300	.....do.....	1	27	2,469	8,298
Vinton.........	101	415	-	-	-	-	-	-	-	-	-	-	-	-	160	605
Washington.....	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Undistributed..	2,258	8,151	5,253	1	2	68	239	310	3,467	3,777	720	Settle......	58	252	2,431	9,017
Total or average.....	31,142	116,679	12,613	1	2	116	518	637	7,834	.8,471	670		287	350	34,471	128,520

1/ Water, if acid, is usually neutralized before use.
2/ Water requirements calculated to nearest 10 gallons.
3/ Intake water, before use, is usually pumped to recirculating pond or tank.
4/ Water lost by evaporation or retained in the washed product.
5/ Included in "Undistributed" to avoid disclosing individual operations.

In 1962, about 68 percent of the bituminous coal production was washed. The average quantity of water used was 610 gallons per ton. The sources of intake water were (1) streams - 54 percent, (2) mines - 31 percent, (3) wells - 13 percent, and (4) purchases - 2 percent (tables 3 - 4 and 3 - 7).

Virginia

The bituminous coalbeds in Virginia are in the Pottsville Formation except for one or two local beds immediately below the Pottsville in the upper Mississippian formations.

The 1962, bituminous coal production in Virginia, more than 29 million tons valued at about $118 million, was about 10 percent of the Appalachian total for that year. The 1964 production was 9 percent of the Appalachia total.

In 1962, about 40 percent of the bituminous coal production was washed. The average quantity of water used was 830 gallons per ton. The sources of intake water were (1) streams - 74 percent, (2) mines - 19 percent, (3) wells - 7 percent, and (4) purchases - none (tables 3 - 4 and 3 - 8).

Maryland

The bituminous coalbeds in Maryland are in the Dunkard Group and the Monongahela, Conemaugh, Allegheny, and Pottsville Formations. The most important, as far as coal production is concerned, are in the Monongahela and the Allegheny Formations.

The 1962 coal production in the State was more than 800,000 tons valued at about $3 million. The 1964 coal production was more than 1.1 million tons valued at more than $4.5 million.

There is no Bureau of Mines record of coal washed in Maryland for 1962.

Kentucky

The bituminous coalbeds in eastern Kentucky are in the Monongahela, Conemaugh, Allegheny, and Pottsville Formations. The most important for coal production is in the Pottsville Formation.

The 1962 coal production in eastern Kentucky was more than 37 million tons valued at about $163 million. The 1964 production in the eastern part of the State was about 45 million tons valued at about $186 million.

In 1962, about 37 percent of the bituminous coal produced in eastern Kentucky was washed. The average volume of water used per ton of washed product was 790 gallons. The sources of intake water

TABLE 3 - 7. - Water requirements for preparation of bituminous coal in the Appalachian region of ...

(All figures are for 1962 unless otherwise specified)

County	Bituminous coal production			Water use (million gallons)							Gallons of water per ton of product 2/	Wat... treat... metho...
	Quantity (1,000 tons)	Value ($1,000)	Washed (1,000 tons)	Intake water by source					Recircu-lating	Total		
				Purchased	Wells	Mine 1/	Stream 1/	Total				
Barbour........	3,054	13,190	1,521	-	13	69	40	122	258	380	250	Settle, neutr...
Boone..........	5,934	26,941	4,946	-	32	-	306	338	1,290	1,628	330	......do...
Braxton........	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-
Brooke.........	734	2,647	(5/)	-	(5/)	-	(5/)	(5/)	-	(5/)	(5/)	Settle, filter...
Clay...........	827	3,768	(5/)	-	(5/)	-	(5/)	(5/)	(5/)	(5/)	(5/)	Settle...
Fayette........	4,795	22,333	1,994	33	4	60	53	150	640	790	400	Settle, neutral... filter...
Gilmer.........	1,025	4,336	(5/)	-	-	-	(5/)	(5/)	(5/)	(5/)	(5/)	Settle, neutral...
Grant..........	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-
Greenbrier.....	454	1,954	-	-	-	-	-	-	-	-	-	-
Hancock........	-	-	-	-	-	-	-	-	-	-	-	-
Harrison.......	6,472	27,175	3,436	-	-	65	102	167	1,206	1,373	400	Settle, neutral...
Kanawha........	10,583	44,174	6,854	2	8	64	314	388	347	735	110	Settle, neutral... filter...
Lewis..........	296	981	(5/)	-	-	-	(5/)	(5/)	(5/)	(5/)	(5/)	Settle...
Lincoln........	33	73	-	-	-	-	-	-	-	-	-	-
Logan..........	15,527	67,547	14,242	-	11	512	678	1,201	10,307	11,508	810	Settle, neutral... filter...
McDowell.......	13,762	88,288	10,321	1	279	685	266	1,231	10,722	11,953	1,160	......do...
Marion.........	9,150	48,907	8,586	62	-	180	517	759	4,103	4,862	570	......do...
Marshall.......	(5/)	(5/)	(5/)	(5/)	(5/)	(5/)	-	(5/)	(5/)	(5/)	(5/)	Settle...
Mason..........	454	1,455	-	-	-	-	-	-	-	-	-	-
Mercer.........	959	6,006	(5/)	-	(5/)	-	(5/)	(5/)	(5/)	(5/)	(5/)	Settle, neutral... filter...
Mineral........	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-
Mingo..........	5,432	26,789	4,834	-	3	171	338	512	3,401	3,913	810	Settle, filter...
Monongalia.....	5,820	28,152	(5/)	(5/)	(5/)	-	(5/)	(5/)	(5/)	(5/)	(5/)	Settle...
Nicholas.......	5,768	28,636	3,566	-	10	60	231	301	1,249	1,550	440	Settle, filter...
Ohio...........	(5/)	(5/)	(5/)	(5/)	(5/)	-	(5/)	(5/)	(5/)	(5/)	(5/)	......do...
Pocahontas.....	386	1,407	-	-	-	-	-	-	-	-	-	-
Preston........	2,998	11,036	(5/)	-	(5/)	(5/)	(5/)	(5/)	(5/)	(5/)	(5/)	Settle...
Putnam.........	75	371	-	-	-	-	-	-	-	-	-	-
Raleigh........	6,321	34,778	2,811	1	12	107	87	207	1,020	1,227	440	Settle, neutral... filter...
Randolph.......	720	2,963	-	-	-	-	-	-	-	-	-	-
Taylor.........	450	1,431	-	-	-	-	-	-	-	-	-	-
Tucker.........	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-
Upshur.........	1,176	5,071	188	-	(5/)	-	(5/)	(5/)	-	(5/)	(5/)	Settle...
Wayne..........	62	276	-	-	-	-	-	-	-	-	-	-
Webster........	772	3,359	164	-	2	1	9	12	51	63	170	Settle...
Wyoming........	10,234	55,599	7,419	-	159	213	251	623	4,970	5,593	1,420	Settle, neutral... filter...
Undistributed..	4,226	18,650	9,838	14	370	32	737	1,153	2,461	3,614	370	......do...
Total or average.....	118,499	578,293	80,720	113	903	2,219	3,929	7,164	42,025	49,189	610	

1/ Water, if acid, is usually neutralized before use.
2/ Water requirements calculated to nearest 10 gallons.
3/ Intake water, before use, is usually pumped to recirculating pond or tank.
4/ Water lost by evaporation or retained in the washed product.
5/ Included in "Undistributed" to avoid disclosing individual operations.

Water requirements for preparation of bituminous coal in the Appalachian region of West Virginia

(All figures are for 1962 unless otherwise specified)

	Water use (million gallons)							Gallons of water per ton of product[2]	Water treatment methods[3]	Water disposal (million gallons)		1964 bituminous coal production	
	Intake water by source					Recirculating	Total			Consumed[4]	To settling ponds, streams, or mines	Quantity (1,000 tons)	Value ($1,000)
	Purchased	Wells	Mine[1]	Stream[1]	Total								
	-	13	69	40	122	258	380	250	Settle, neutralize..	20	102	2,328	10,108
	-	32	-	306	338	1,290	1,628	330	......do.....	118	220	8,593	38,454
	-	-	-	-	-	-	-	-	-	-	-	74	324
	-	(5/)	-	(5/)	(5/)	-	(5/)	(5/)	Settle, filter......	(5/)	(5/)	1,030	3,422
	-	(5/)	-	(5/)	(5/)	(5/)	(5/)	(5/)	Settle.......	(5/)	(5/)	73	301
	33	4	60	53	150	640	790	400	Settle, neutralize, filter......	65	85	5,738	25,881
	-	-	-	(5/)	(5/)	(5/)	(5/)	(5/)	Settle, neutralize..	(5/)	(5/)	(5/)	(5/)
	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
	-	-	-	-	-	-	-	-	-	-	-	945	4,069
	-	-	-	-	-	-	-	-	-	-	-	35	92
5	-	-	65	102	167	1,206	1,373	400	Settle, neutralize..	67	100	8,287	34,351
4	2	8	64	314	388	347	735	110	Settle, neutralize, filter......	154	234	11,002	49,180
)	-	-	-	(5/)	(5/)	(5/)	(5/)	(5/)	Settle.......	(5/)	(5/)	170	581
	-	-	-	-	-	-	-	-	-	-	-	18	45
2	-	11	512	678	1,201	10,307	11,508	810	Settle, neutralize, filter......	261	940	15,886	71,771
1	1	279	685	266	1,231	10,722	11,953	1,160	......do.....	393	838	17,310	106,715
6	62	-	180	517	759	4,103	4,862	570	......do.....	239	520	11,768	60,942
)	(5/)	(5/)	(5/)	-	(5/)	(5/)	(5/)	(5/)	Settle.......	(5/)	(5/)	(5/)	(5/)
	-	-	-	-	-	-	-	-	-	-	-	458	1,537
)	-	(5/)	-	(5/)	(5/)	(5/)	(5/)	(5/)	Settle, neutralize, filter......	(5/)	(5/)	1,462	8,751
	-	-	-	-	-	-	-	-	-	-	-	73	293
4	-	3	171	338	512	3,401	3,913	810	Settle, filter......	122	390	5,609	28,332
)	(5/)	(5/)	-	(5/)	(5/)	(5/)	(5/)	(5/)	Settle.......	(5/)	(5/)	8,528	41,443
6	-	10	60	231	301	1,249	1,550	440	Settle, filter......	60	241	7,856	37,792
)	(5/)	(5/)	-	(5/)	(5/)	(5/)	(5/)	(5/)	......do.....	(5/)	(5/)	(5/)	(5/)
	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
)	-	(5/)	(5/)	(5/)	(5/)	(5/)	(5/)	(5/)	Settle.......	(5/)	(5/)	3,534	13,087
	-	-	-	-	-	-	-	-	-	-	-	5	22
1	1	12	107	87	207	1,020	1,227	440	Settle, neutralize, filter......	87	120	7,657	42,777
	-	-	-	-	-	-	-	-	-	-	-	1,051	3,874
	-	-	-	-	-	-	-	-	-	-	-	430	1,384
	-	-	-	-	-	-	-	-	-	-	-	245	843
8	-	(5/)	-	(5/)	(5/)	-	(5/)	(5/)	Settle.......	(5/)	(5/)	422	1,691
	-	-	-	-	-	-	-	-	-	-	-	30	139
4	-	2	1	9	12	51	63	170	Settle.......	7	5	825	3,501
9	-	159	213	251	623	4,970	5,593	1,420	Settle, neutralize, filter......	187	436	13,480	72,811
8	14	370	32	737	1,153	2,461	3,614	370	......do.....	249	904	6,486	29,059
0	113	903	2,219	3,929	7,164	42,025	49,189	610		2,029	5,135	141,408	693,572

before use.
t 10 gallons.
mped to recirculating pond or tank.
the washed product.
sclosing individual operations.

TABLE 3 - 8. - Water requirements for preparation of bituminous coal in the Appalachian region of Virginia

(All figures are for 1962 unless otherwise specified)

County	Bituminous coal production			Water use (million gallons)							Gallons of water per ton of product 2/	Water treatment methods 3/	Water disposal (million gallons)		1964 bituminous coal production	
	Quantity (1,000 tons)	Value ($1,000)	Washed (1,000 tons)	Intake water by source					Recirculating	Total			Consumed 4/	To settling ponds, streams, or mines	Quantity (1,000 tons)	Value ($1,000)
				Purchased	Wells	Mine 1/	Stream 1/	Total								
Buchanan.......	11,997	45,179	1,900	-	20	242	112	374	601	975	510	Settle, filter.....	23	351	14,502	57,379
Dickenson......	8,356	35,119	7,421	-	(5/)	-	(5/)	(5/)	(5/)	(5/)	(5/)	Settle......	(5/)	(5/)	7,728	28,510
Lee............	453	1,666	-	-	-	-	-	-	-	-	-	-	-	-	471	1,826
Russell........	2,024	9,461	1,363	-	(5/)	(5/)	(5/)	(5/)	(5/)	(5/)	(5/)	Settle......	(5/)	(5/)	1,900	7,317
Scott..........	12	61	-	-	-	-	-	-	-	-	-	-	-	-	4	17
Tazewell.......	460	1,500	-	-	-	-	-	-	-	-	-	-	-	-	237	787
Wise...........	6,161	24,532	1,231	-	-	-	359	359	312	671	550	Settle, filter.....	51	308	6,804	27,258
Undistributed..	-	-	-	-	102	65	739	906	7,334	8,240	-	Settle......	211	695	-	-
Total or average.....	29,463	117,518	11,915	-	122	307	1,210	1,639	8,247	9,886	830		285	1,354	31,646	123,094

1/ Water, if acid, is usually neutralized before use.
2/ Water requirements calculated to nearest 10 gallons.
3/ Intake water, before use, is usually pumped to recirculating pond or tank.
4/ Water lost by evaporation or retained in the washed product.
5/ Included in "Undistributed" to avoid disclosing individual operations.

were (1) wells - 49 percent, (2) streams - 49 percent, (3) purchases - 2 percent, and (4) mines - none (tables 3 - 4 and 3 - 9).

Tennessee

The bituminous coalbeds in eastern Tennessee are in the Pottsville Formation.

The 1962 bituminous coal production for Tennessee was more than 6 million tons, valued at about $23 million. The 1962 production was about 2 percent of the Appalachia total production. The 1964 production was about 6 million tons valued at about $23 million. The 1964 production was also about 2 percent of the total produced in Appalachia (table 3 - 4).

There is no Bureau of Mines record of water used to prepare coal in Tennessee for 1962.

Georgia

The bituminous coalbeds in Georgia are in the Pottsville Formation.

The 1962 bituminous coal production in Georgia was about 8,000 tons valued at $28,000. The 1964 production was 4,000 tons valued at $15,000 (table 3 - 4).

There is no Bureau of Mines record of water used to prepare coal in Georgia for 1962.

Alabama

The bituminous coalbeds in Alabama are in the Pottsville Formation.

The 1962 bituminous coal production in Alabama, about 13 million tons valued at more than $95 million, was about 4 percent of the Appalachia total for that year. The 1964 production, more than 14 million tons valued at about $102 million, was about 4 percent of Appalachia total.

In 1962, about 80 percent of the bituminous coal production was washed. The average quantity of water used was 950 gallons per ton. The sources of water were (1) streams - 97 percent, (2) purchases - 2 percent, (3) wells - 1 percent, and (4) mines - none (tables 3 - 4 and 3 - 10).

SAND AND GRAVEL

In 1962, about 4 percent of the total sand and gravel produced in the United States was produced in Appalachia. The output from the

TABLE 3 - 9. Water requirements for preparation of bituminous coal in the Appalachian region of Kentucky

(All figures are for 1962 unless otherwise specified)

County	Bituminous coal production			Water use (million gallons)							Gallons of water per ton of product2/	Water treatment methods3/	Water disposal (million gallons)		1964 bituminous coal production	
				Intake water by source					Recircu-lating	Total						
	Quantity (1,000 tons)	Value ($1,000)	Washed (1,000 tons)	Purchased	Wells	Mine1/	Stream1/	Total					Consumed4/	To settling ponds, streams, or mines	Quantity (1,000 tons)	Value ($1,000)
Bell..........	1,848	7,315	293	-	-	-	36	36	286	322	1,100	Settle......	4	32	2,068	7,041
Boyd..........	56	158	-	-	-	-	-	-	-	-	-	-	-	-	41	155
Breathitt......	603	3,515	464	-	7	-	4	11	80	91	200	Settle......	2	9	260	964
Carter........	24	122	-	-	-	-	-	-	-	-	-	-	-	-	27	108
Clay..........	1,065	4,077	-	-	-	-	-	-	-	-	-	-	-	-	1,485	5,849
Clinton........	5	25	-	-	-	-	-	-	-	-	-	-	-	-	14	58
Elliott........	16	55	-	-	-	-	-	-	-	-	-	-	-	-	14	64
Estill5/.......	-	-	286	-	-	-	1	1	672	673	2,180	Settle......	1	-	-	-
Floyd.........	3,747	20,529	3,036	-	101	-	96	197	2,148	2,345	770	.....do.....	20	177	4,680	25,404
Harlan........	5,528	28,746	1,845	3	126	-	81	210	1,844	2,054	1,110	.....do.....	21	189	5,642	28,439
Jackson........	27	136	-	-	-	-	-	-	-	-	-	-	-	-	45	219
Johnson........	180	603	-	-	-	-	-	-	-	-	-	-	-	-	262	846
Knott.........	1,969	6,232	-	-	-	-	-	-	-	-	-	-	-	-	2,059	6,248
Knox..........	280	935	-	-	-	-	-	-	-	-	-	-	-	-	267	932
Laurel.........	107	380	-	-	-	-	-	-	-	-	-	-	-	-	137	523
Lawrence.......	17	68	-	-	-	-	-	-	-	-	-	-	-	-	9	29
Lee...........	50	203	-	-	-	-	-	-	-	-	-	-	-	-	61	244
Leslie.........	1,805	6,932	516	-	-	-	10	10	77	87	170	Settle......	1	9	1,807	7,452
Letcher........	5,064	25,366	1,886	2	196	-	17	215	2,230	2,445	1,300	.....do.....	22	193	5,574	24,219
Magoffin.......	44	133	-	-	-	-	-	-	-	-	-	-	-	-	96	318
Martin.........	69	313	-	-	-	-	-	-	-	-	-	-	-	-	197	820
McCreary.......	360	1,269	-	-	-	-	-	-	-	-	-	-	-	-	466	1,630
Morgan.........	40	158	-	-	-	-	-	-	-	-	-	-	-	-	37	167
Owsley.........	2	11	-	-	-	-	-	-	-	-	-	-	-	-	9	28
Perry..........	3,474	14,531	1,973	-	36	-	69	105	1,180	1,285	650	Settle......	11	94	3,944	11,295
Pike..........	9,946	37,555	2,623	10	8	-	191	209	700	909	350	.....do.....	21	188	14,836	59,812
Pulaski........	88	386	-	-	-	-	-	-	-	-	-	-	-	-	158	526
Rockcastle.....	10	33	-	-	-	-	-	-	-	-	-	-	-	-	1	5
Wayne..........	2	8	-	-	-	-	-	-	-	-	-	-	-	-	52	149
Whitley........	718	2,749	660	3	33	-	-	36	543	579	880	Settle......	4	32	638	1,994
Wolfe..........	11	53	-	-	-	-	-	-	-	-	-	-	-	-	9	37
Total or average.....	37,155	162,596	13,582	18	507	-	505	1,030	9,760	10,790	790		107	923	44,895	185,575

1/ Water, if acid, is usually neutralized before use.
2/ Water requirements calculated to nearest 10 gallons.
3/ Intake water, before use, is usually pumped to recirculating pond or tank.
4/ Water lost by evaporation or retained in the washed product.
5/ Petroleum and limestone only commodities produced in 1962 and 1964.

TABLE 3 - 10. - Water requirements for preparation of bituminous coal in the Appalachian region of Alabama

(All figures are for 1962 unless otherwise specified)

County	Bituminous coal production			Water use (million gallons)							Gallons of water per ton of product2/	Water treatment methods3/	Water disposal (million gallons)		1964 bituminous coal production	
	Quantity (1,000 tons)	Value ($1,000)	Washed (1,000 tons)	Intake water by source: Purchased	Wells	Mine1/	Stream1/	Total	Recircu-lating	Total			Consumed4/	To settling ponds, streams, or mines	Quantity (1,000 tons)	Value ($1,000)
Bibb...........	43	224	19	-	-	-	3	3	30	33	1,580	Settle......	1	2	230	954
Blount.........	130	655	-	-	-	-	-	-	-	-	-	-	-	-	3	14
Cullman........	10	58	8	-	-	-	2	2	16	18	2,250	Settle......	1	1	8	64
Etowah.........	-	-	-	-	-	-	-	-	-	-	-	-	-	-	127	672
Jackson........	15	104	-	-	-	-	-	-	-	-	-	-	-	-	164	775
Jefferson......	6,812	53,438	6,093	43	16	-	1,418	1,477	4,726	6,203	1,020	Settle......	150	1,327	7,455	59,774
Marion.........	244	977	101	-	-	-	18	18	54	72	710	.....do.....	2	16	320	1,419
St. Clair......	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	10
Shelby.........	534	4,634	516	-	11	-	43	54	443	497	960	Settle......	5	49	687	5,723
Tuscaloosa.....	693	3,258	473	-	-	-	5	5	44	49	100	.....do.....	1	4	1,101	4,797
Walker.........	4,271	31,198	2,950	-	-	-	766	766	2,017	2,783	940	.....do.....	80	686	4,183	27,306
Winston........	129	603	25	-	-	-	4	4	37	41	1,640	.....do.....	1	3	153	759
Total or average5/...	12,881	95,149	10,185	43	27	-	2,259	2,329	7,367	9,696	950		241	2,088	14,435	102,267

1/ Water, if acid, is usually neutralized before use.
2/ Water requirements calculated to nearest 10 gallons.
3/ Intake water, before use, is usually pumped to recirculating pond or tank.
4/ Water lost by evaporation or retained in the washed product.
5/ Excludes counties added to Appalachia by PL 90-103.

area was about 30 million tons valued at about $47 million (table 3 - 11). About 77 percent of the total sand and gravel produced in the 12 States was washed.

Excavation and Preparation

Production of sand and gravel on a large scale usually entails excavating with a power shovel, dragline, dredge, pump, highlift, or similar equipment, and then washing and separating according to particle size in a processing plant. Such processing normally requires substantial quantities of water.

Water Use

The average quantity of water used for preparing sand and gravel in Appalachia in 1962 was 980 gallons per ton of product, based on washed sand and gravel only. About 89 percent of the intake water used for the 23 million tons prepared was pumped from streams, and the remaining 11 percent was taken from ground-water sources (table 3 - 11). After use, the wash water is pumped to settling basins to remove solids.

Water Quality

The sand and gravel industry has no formal specifications or standards for the quality of wash water used. However, wash water must be free of floating solids that may cling to and interfere with the finished product. Water from streams may be freed of floating solids by screens and settling ponds. Wash water must be free of acid or alkaline impurities that might cause corrosion of washing, crushing, and screening equipment; in addition, water should be relatively free of suspended solids that might interfere with effective washing of the product, preventing its meeting roadbuilding or other specifications.

New York

Many of the sand and gravel deposits in the Appalachian region of New York are of glacial origin. Some are outwash deposits made by melt water flowing over, under, or alongside the ice. Some of the glacial sand and gravel deposits have been washed away by modern streams and redeposited in downstream areas as alluvial deposits.

In 1962, about 11 percent of the sand and gravel produced in Appalachia was from 13 counties of southwestern New York (tables 3 - 11 and 3 - 12). The output from these 13 counties was more than 3 million tons valued at about $4 million. About 87 percent of the production was washed.

The average quantity of water used to wash the Appalachian portion of 1962 production from New York was 760 gallons per ton, based on washed sand and gravel only. Of the intake water used,

TABLE 3 - 11. - Water requirements for preparation of sand and gravel in Appalachia
(All figures are for 1962 unless otherwise specified)

State	Sand and gravel production			Water use (million gallons)							Gallons of water per ton of product 2/	Water treatment methods 3/	Water disposal (million gallons)		1964 sand and gravel production	
	Quantity (1,000 tons)	Value ($1,000)	Washed (1,000 tons)	Intake water by source					Recirculating	Total			Consumed 4/	To settling ponds, streams, or mines	Quantity (1,000 tons)	Value ($1,000)
				Purchased	Wells	Mine 1/	Stream 1/	Total								
New York.......	3,234	3,923	2,477	-	551	-	851	1,402	492	1,894	760	Settle......	43	1,359	3,577	4,433
Pennsylvania...	8,515	15,426	7,328	12	213	-	4,736	4,961	2,253	7,214	990	.....do.....	196	4,765	10,649	18,092
Maryland.......	(5/)	(5/)	(5/)	-	-	-	(5/)	(5/)	-	(5/)	(5/)	.....do.....	(5/)	(5/)	295	790
Ohio...........	4,889	7,530	4,351	-	750	32	1,854	2,636	1,164	3,800	870	.....do.....	166	2,470	4,584	7,169
Kentucky.......	5	5	-	-	-	-	-	-	-	-	-	-	-	-	4	4
West Virginia..	5,202	10,942	4,991	-	48	-	3,768	3,816	3,845	7,661	1,530	Settle......	148	3,668	5,472	11,555
Virginia.......	(5/)	(5/)	(5/)	-	-	-	(5/)	(5/)	-	(5/)	(5/)	.....do.....	(5/)	(5/)	208	366
Tennessee......	1,334	2,145	374	-	2	-	122	124	120	244	650	.....do.....	20	104	1,682	2,656
North Carolina.	4,339	3,938	2,225	-	-	-	960	960	-	960	430	.....do.....	99	861	2,733	2,615
South Carolina.	118	118	-	-	-	-	-	-	-	-	-	-	-	-	169	208
Georgia........	40	47	40	20	-	-	25	45	1	46	1,150	Settle......	5	40	1	2
Alabama........	1,388	1,366	419	-	-	-	11	11	72	83	200	.....do.....	2	9	1,679	1,968
Undistributed..	417	1,081	397	-	-	-	220	220	-	220	550	-	16	204	-	-
Total or average 6/...	29,481	46,521	22,602	32	1,564	32	12,547	14,175	7,947	22,122	980		695	13,480	31,053	49,858

1/ Water, if acid, is usually neutralized before use.
2/ Water requirements calculated to nearest 10 gallons.
3/ Intake water, before use, is usually pumped to recirculating pond or tank.
4/ Water lost by evaporation or retained in the washed product.
5/ Included in "Undistributed" to avoid disclosing individual operations.
6/ Excludes counties added to Appalachia by PL 90-103.

TABLE 3 - 12. - Water requirements for preparation of sand and gravel in the Appalachian region of New York

(All figures are for 1962 unless otherwise specified)

County	Sand and gravel production			Water use (million gallons)							Gallons of water per ton of product2/	Water treatment methods3/	Water disposal (million gallons)		1964 sand and gravel production	
				Intake water by source					Recircu-lating	Total						
	Quantity (1,000 tons)	Value ($1,000)	Washed (1,000 tons)	Purchased	Wells	Mine1/	Stream1/	Total					Consumed4/	To settling ponds, streams, or mines	Quantity (1,000 tons)	Value ($1,000)
Allegany.......	308	387	302	-	76	-	116	192	8	200	660	Settle......	6	186	314	406
Broome.........	438	672	367	-	-	-	215	215	10	225	610	.....do.....	9	206	537	801
Cattaraugus....	939	1,056	871	-	366	-	372	738	1	739	850	.....do.....	14	724	871	1,009
Chautauqua.....	242	155	(5/)	-	(5/)	-	-	(5/)	(5/)	(5/)	(5/)	.....do.....	(5/)	(5/)	(5/)	(5/)
Chemung........	(5/)	(5/)	(5/)	-	(5/)	-	-	(5/)	-	(5/)	(5/)	.....do.....	(5/)	(5/)	(5/)	(5/)
Chenango.......	(5/)	(5/)	(5/)	-	(5/)	-	-	(5/)	-	(5/)	(5/)	.....do.....	(5/)	(5/)	124	195
Cortland.......	71	111	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Delaware.......	13	2	-	-	-	-	-	-	-	-	-	-	-	-	8	3
Otsego.........	(5/)	(5/)	(5/)	-	-	-	(5/)	(5/)	-	(5/)	(5/)	Settle......	(5/)	(5/)	(5/)	(5/)
Schuyler.......	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Steuben........	397	528	281	-	35	-	15	50	375	425	1,510	Settle......	5	45	(5/)	(5/)
Tioga..........	312	296	(5/)	-	(5/)	-	(5/)	(5/)	(5/)	(5/)	(5/)	.....do.....	(5/)	(5/)	272	327
Tompkins.......	(5/)	(5/)	(5/)	-	-	-	(5/)	(5/)	(5/)	(5/)	(5/)	.....do.....	(5/)	(5/)	(5/)	(5/)
Undistributed..	514	716	656	-	74	-	133	207	98	305	460	.....do.....	9	198	1,451	1,692
Total or average6/...	3,234	3,923	2,477	-	551	-	851	1,402	492	1,894	760		43	1,359	3,577	4,433

1/ Water, if acid, is usually neutralized before use.
2/ Water requirements calculated to nearest 10 gallons.
3/ Intake water, before use, is usually pumped to recirculating pond or tank.
4/ Water lost by evaporation or retained in the washed product.
5/ Included in "Undistributed" to avoid disclosing individual operations.
6/ Excludes Schoharie County added to Appalachia by PL 90-103.

about 61 percent was pumped from streams and the remaining 39 percent was obtained from ground-water sources.

Pennsylvania

Many of the sand and gravel deposits in Pennsylvania are terraces and alluvial plains formed by glacial and modern streams.

In 1962, Pennsylvania was the leading producer of sand and gravel in Appalachia with about 29 percent of the total production. The production of about 9 million tons valued at more than $15 million was from 39 of the 52 counties in Appalachia. About 86 percent of this production was washed (tables 3 - 11 and 3 - 13).

The average quantity of water used in Pennsylvania was 990 gallons per ton of product, based upon washed sand and gravel only. Of the intake water used, about 96 percent was obtained from surface water sources, principally streams, and the remaining 4 percent was pumped from ground-water sources.

Ohio

Some sand and gravel deposits in Ohio are terraces and alluvium of ancient and modern rivers. Others are glacial outwash.

In 1962, about 17 percent of the total sand and gravel from Appalachia was produced in Ohio. In Ohio about 5 million tons valued at about $8 million was produced from 19 of the 28 Appalachian counties. About 89 percent of this production was washed (tables 3 - 11 and 3 - 14).

The average quantity of water used in Ohio was 870 gallons per ton of product, based upon washed sand and gravel only. Of the intake water used, about 71 percent was obtained from surface water sources, principally streams, about 28 percent from ground-water sources, and the remaining 1 percent from mines.

West Virginia

Most of the sand and gravel deposits in West Virginia are Recent alluvium. Along the Ohio River, some deposits are in terraces or in the channel of the river.

In 1962, about 18 percent of the Appalachia total sand and gravel was produced in 17 out of 55 counties in West Virginia. The output for the 17 counties in 1962 was more than 5 million tons valued at about $11 million. About 96 percent of the total product was washed (tables 3 - 11 and 3 - 15).

The average quantity of water used was about 1,530 gallons per ton of product, based upon washed sand and gravel only. Of the intake water used, 99 percent was obtained from surface water sources,

TABLE 3 - 13. - Water requirements for preparation of sand and gravel in the Appalachian region of Pennsylvania

(All figures are for 1962 unless otherwise specified)

County	Sand and gravel production			Water use (million gallons)							Gallons of water per ton of product2/	Water treatment methods3/	Water disposal (million gallons)		1964 sand and gravel production	
	Quantity (1,000 tons)	Value ($1,000)	Washed (1,000 tons)	Intake water by source					Recirculating	Total			Consumed4/	To settling ponds, streams, or mines	Quantity (1,000 tons)	Value ($1,000)
				Purchased	Wells	Mine1/	Stream1/	Total								
Allegheny	210	371	(5/)	-	-	-	(5/)	(5/)	(5/)	(5/)	(5/)	-	(5/)	(5/)	(5/)	(5/)
Armstrong	1,209	2,492	1,159	-	-	-	138	138	224	362	310	Settle, filter	22	116	477	787
Beaver	(5/)	(5/)	(5/)	-	-	-	(5/)	(5/)	(5/)	(5/)	(5/)	Settle	(5/)	(5/)	854	1,170
Bedford	(5/)	(5/)	(5/)	-	-	-	(5/)	(5/)	(5/)	(5/)	(5/)	do	(5/)	(5/)	-	-
Blair	(5/)	(5/)	(5/)	-	-	-	(5/)	(5/)	(5/)	(5/)	(5/)	do	(5/)	(5/)	(5/)	(5/)
Bradford	(5/)	(5/)	(5/)	-	-	-	(5/)	(5/)	(5/)	(5/)	(5/)	do	(5/)	(5/)	(5/)	(5/)
Butler	135	166	109	-	-	-	89	89	30	119	1,090	Settle, filter	27	62	164	219
Cambria	(5/)	(5/)	(5/)	-	-	-	(5/)	(5/)	(5/)	(5/)	(5/)	Settle	(5/)	(5/)	(5/)	(5/)
Carbon	218	315	218	-	16	-	3	19	13	32	150	do	2	17	(5/)	(5/)
Clarion	(5/)	(5/)	(5/)	-	-	-	(5/)	(5/)	(5/)	(5/)	(5/)	do	(5/)	(5/)	(5/)	(5/)
Clearfield	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Clinton	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	24
Columbia	(5/)	(5/)	(5/)	-	-	-	(5/)	(5/)	(5/)	(5/)	(5/)	Settle	(5/)	(5/)	(5/)	(5/)
Crawford	(5/)	(5/)	(5/)	-	(5/)	-	-	(5/)	(5/)	(5/)	(5/)	do	(5/)	(5/)	92	108
Elk	(5/)	(5/)	(5/)	-	-	-	(5/)	(5/)	(5/)	(5/)	(5/)	do	(5/)	(5/)	(5/)	(5/)
Erie	(5/)	(5/)	(5/)	-	(5/)	-	(5/)	(5/)	(5/)	(5/)	(5/)	do	(5/)	(5/)	1,613	2,086
Fayette	162	349	(5/)	-	-	-	(5/)	(5/)	(5/)	(5/)	(5/)	do	(5/)	(5/)	51	114
Forest	(5/)	(5/)	(5/)	-	-	-	(5/)	(5/)	(5/)	(5/)	(5/)	do	(5/)	(5/)	(5/)	(5/)
Fulton	(5/)	(5/)	(5/)	-	-	-	(5/)	(5/)	(5/)	(5/)	(5/)	do	(5/)	(5/)	(5/)	(5/)
Huntingdon	(5/)	(5/)	(5/)	-	(5/)	-	(5/)	(5/)	(5/)	(5/)	(5/)	do	(5/)	(5/)	(5/)	(5/)
Jefferson	9	4	(5/)	-	-	-	(5/)	(5/)	(5/)	(5/)	(5/)	do	(5/)	(5/)	(5/)	(5/)
Lackawanna	186	190	(5/)	-	-	-	(5/)	(5/)	(5/)	(5/)	(5/)	do	(5/)	(5/)	261	288
Lawrence	(5/)	(5/)	(5/)	-	-	-	(5/)	(5/)	(5/)	(5/)	(5/)	do	(5/)	(5/)	(5/)	(5/)
Luzerne	433	523	405	12	-	-	117	129	136	265	120	Settle, chlorinate.	10	119	631	754
Lycoming	(5/)	(5/)	(5/)	-	(5/)	-	-	(5/)	(5/)	(5/)	(5/)	Settle	(5/)	(5/)	(5/)	(5/)
McKean	(5/)	(5/)	(5/)	-	-	-	(5/)	(5/)	(5/)	(5/)	(5/)	do	(5/)	(5/)	10	10
Mercer	223	294	126	-	-	-	97	97	145	242	90	Settle, filter	6	91	735	889
Mifflin	(5/)	(5/)	(5/)	-	-	-	(5/)	(5/)	(5/)	(5/)	(5/)	Settle	(5/)	(5/)	(5/)	(5/)
Monroe	78	85	78	-	27	-	-	27	(5/)	27	30	do	1	26	(5/)	(5/)
Montour	(5/)	(5/)	(5/)	-	-	-	(5/)	(5/)	(5/)	(5/)	(5/)	do	(5/)	(5/)	(5/)	(5/)
Schuylkill	91	221	91	-	-	-	15	15	61	76	840	do	1	14	124	257
Snyder	(5/)	(5/)	(5/)	-	(5/)	-	(5/)	(5/)	(5/)	(5/)	(5/)	do	(5/)	(5/)	162	185
Somerset	1	3	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Tioga	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Venango	(5/)	(5/)	(5/)	-	-	-	(5/)	(5/)	-	(5/)	-	Settle	(5/)	(5/)	(5/)	(5/)
Warren	156	226	(5/)	-	(5/)	-	(5/)	(5/)	-	(5/)	-	do	(5/)	(5/)	261	412
Wayne	(5/)	(5/)	(5/)	-	-	-	(5/)	(5/)	-	(5/)	-	do	(5/)	(5/)	132	178
Westmoreland	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Wyoming	(5/)	(5/)	(5/)	-	(5/)	-	(5/)	(5/)	(5/)	(5/)	-	Settle	(5/)	(5/)	(5/)	(5/)
Undistributed	5,404	10,187	5,142	-	170	-	4,277	4,447	1,644	6,091	1,190	-	127	4,320	5,078	10,611
Total or average	8,515	15,426	7,328	12	213	-	4,736	4,961	2,253	7,214	990		196	4,765	10,649	18,092

1/ Water, if acid, is usually neutralized before use.
2/ Water requirements calculated to nearest 10 gallons.
3/ Intake water, before use, is usually pumped to recirculating pond or tank.
4/ Water lost by evaporation or retained in the washed product.
5/ Included in "Undistributed" to avoid disclosing individual operations.

TABLE 3 - 14. - Water requirements for preparation of sand and gravel in the Appalachian region of Ohio

(All figures are for 1962 unless otherwise specified)

County	Sand and gravel production			Water use (million gallons)							Gallons of water per ton of product 2/	Water treatment methods 3/	Water disposal (million gallons)		1964 sand and gravel production	
	Quantity (1,000 tons)	Value ($1,000)	Washed (1,000 tons)	Intake water by source					Recirculating	Total			Consumed 4/	To settling ponds, streams, or mines	Quantity (1,000 tons)	Value ($1,000)
				Purchased	Wells	Mine 1/	Stream 1/	Total								
Athens........	(5/)	(5/)	(5/)	-	-	-	(5/)	(5/)	(5/)	(5/)	(5/)	Settle......	(5/)	(5/)	(5/)	(5/)
Brown.........	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	2	3
Carroll.......	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Clermont......	470	684	470	-	-	-	192	192	-	192	410	Settle......	28	164	-	-
Coshocton.....	488	555	482	-	254	-	31	285	21	306	640	.....do.....	17	268	529	617
Gallia........	(5/)	(5/)	(5/)	-	-	-	(5/)	(5/)	-	(5/)	(5/)	.....do.....	(5/)	(5/)	(5/)	(5/)
Highland......	33	35	-	-	-	-	-	-	-	-	-	-	-	-	44	48
Holmes........	126	112	99	-	-	32	2	34	-	34	340	Settle......	2	32	(5/)	(5/)
Lawrence......	(5/)	(5/)	(5/)	-	-	-	(5/)	(5/)	-	(5/)	(5/)	.....do.....	(5/)	(5/)	231	282
Meigs.........	(5/)	(5/)	(5/)	-	-	-	(5/)	(5/)	-	(5/)	(5/)	.....do.....	(5/)	(5/)	(5/)	(5/)
Monroe........	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Morgan........	(5/)	(5/)	(5/)	-	-	-	(5/)	(5/)	-	(5/)	(5/)	Settle......	(5/)	(5/)	(5/)	(5/)
Muskingum.....	(5/)	(5/)	(5/)	-	(5/)	-	(5/)	(5/)	-	(5/)	(5/)	.....do.....	(5/)	(5/)	(5/)	(5/)
Perry.........	(5/)	(5/)	(5/)	-	-	-	(5/)	(5/)	(5/)	(5/)	(5/)	.....do.....	(5/)	(5/)	(5/)	(5/)
Pike..........	407	772	(5/)	-	(5/)	-	(5/)	(5/)	(5/)	(5/)	(5/)	.....do.....	(5/)	(5/)	(5/)	(5/)
Ross..........	575	524	575	-	77	-	275	352	115	467	810	.....do.....	16	336	657	599
Scioto........	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	95	121
Tuscarawas....	570	779	510	-	192	-	68	260	-	260	510	Settle......	12	248	675	982
Washington....	293	360	272	-	101	-	151	252	-	252	930	.....do.....	9	243	247	312
Undistributed.	1,927	3,709	1,943	-	126	-	1,135	1,261	1,028	2,289	1,180	.....do.....	82	1,179	2,104	4,205
Total or average....	4,889	7,530	4,351	-	750	32	1,854	2,636	1,164	3,800	870		166	2,470	4,584	7,169

1/ Water, if acid, is usually neutralized before use.
2/ Water requirements calculated to nearest 10 gallons.
3/ Intake water, before use, is usually pumped to recirculating pond or tank.
4/ Water lost by evaporation or retained in the washed product.
5/ Included in "Undistributed" to avoid disclosing individual operations.

TABLE 3 - 15. - Water requirements for preparation of sand and gravel in the Appalachian region of West Virginia

(All figures are for 1962 unless otherwise specified)

County	Sand and gravel production			Water use (million gallons)							Gallons of water per ton of product 2/	Water treatment methods 3/	Water disposal (million gallons)		1964 sand and gravel production	
	Quantity (1,000 tons)	Value ($1,000)	Washed (1,000 tons)	Intake water by source					Recircu- lating	Total			Consumed 4/	To settling ponds, streams, or mines	Quantity (1,000 tons)	Value ($1,000)
				Purchased	Wells	Mine 1/	Stream 1/	Total								
Brooke........	303	476	(5/)	-	(5/)	-	(5/)	(5/)	-	(5/)	(5/)	Settle......	(5/)	(5/)	272	415
Cabell.........	(5/)	(5/)	(5/)	-	-	-	(5/)	(5/)	-	(5/)	(5/)	.....do.....	(5/)	(5/)	(5/)	(5/)
Hancock........	(5/)	(5/)	(5/)	-	-	-	(5/)	(5/)	-	(5/)	(5/)	.....do.....	(5/)	(5/)	(5/)	(5/)
Lincoln........	2	4	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Mason..........	37	46	-	-	-	-	-	-	-	-	-	-	-	-	40	59
Mineral........	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Monongalia.....	(5/)	(5/)	(5/)	-	-	-	(5/)	(5/)	(5/)	(5/)	(5/)	Settle......	(5/)	(5/)	(5/)	(5/)
Morgan.........	(5/)	(5/)	(5/)	-	(5/)	-	(5/)	(5/)	(5/)	(5/)	(5/)	.....do.....	(5/)	(5/)	(5/)	(5/)
Ohio...........	(5/)	(5/)	(5/)	-	-	-	(5/)	(5/)	-	(5/)	(5/)	.....do.....	(5/)	(5/)	430	516
Pleasants......	(5/)	(5/)	(5/)	-	-	-	(5/)	(5/)	-	(5/)	(5/)	.....do.....	(5/)	(5/)	-	-
Pocahontas.....	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Raleigh........	3	8	-	-	-	-	-	-	-	-	-	-	-	-	5	15
Tucker.........	(5/)	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Tyler..........	(5/)	(5/)	-	-	-	-	(5/)	(5/)	-	(5/)	(5/)	Settle......	(5/)	(5/)	(5/)	(5/)
Wayne..........	5	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Wetzel.........	(5/)	(5/)	(5/)	-	-	-	(5/)	(5/)	-	(5/)	(5/)	Settle......	(5/)	(5/)	(5/)	(5/)
Wood...........	(5/)	(5/)	(5/)	-	-	-	(5/)	(5/)	-	(5/)	(5/)	.....do.....	(5/)	(5/)	934	1,582
Wyoming........	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	10
Undistributed..	4,852	10,402	4,991	-	48	-	3,768	3,816	3,845	7,661	1,530	Settle......	148	3,668	3,788	8,958
Total or average.....	5,202	10,942	4,991	-	48	-	3,768	3,816	3,845	7,661	1,530		148	3,668	5,472	11,555

1/ Water, if acid, is usually neutralized before use.
2/ Water requirements calculated to nearest 10 gallons.
3/ Intake water, before use, is usually pumped to recirculating pond or tank.
4/ Water lost by evaporation or retained in the washed product.
5/ Included in "Undistributed" to avoid disclosing individual operations.

principally streams. The remaining 1 percent was obtained from ground-water sources.

Virginia

In 1962, the production of sand and gravel from western Virginia and water use were concealed to prevent disclosure of individual operations. The 1964 output of 208,000 tons valued at $366,000 was about 1 percent of the total production in Appalachia (table 3 - 11).

Maryland

In 1962, the production of sand and gravel from western Maryland and water use were concealed to prevent disclosure of individual operations. The 1964 output of 295,000 tons valued at $790,000 was about 1 percent of the total production in Appalachia (table 3 - 11).

Kentucky

In 1962, the State production of sand and gravel and water use were concealed to avoid disclosure of data on individual operations. The 1964 output for eastern Kentucky was 4,000 tons valued at $4,000.

Tennessee

The sand and gravel in eastern Tennessee is obtained from river terraces and Recent alluvium deposits. In 1962, about 5 percent of the Appalachian total was produced in eastern Tennessee in 12 of the 47 counties in Appalachia. About 28 percent of Tennessee's total sand and gravel production was washed (tables 3 - 11 and 3 - 16).

The average quantity of water used in Tennessee in 1962 was 650 gallons per ton, based upon washed sand and gravel only. About 98 percent of the intake water was obtained from streams and the remaining 2 percent from ground-water sources.

North Carolina

Most of the sand and gravel in western North Carolina is in Recent alluvium and river terrace deposits.

In 1962, about 15 percent of Appalachian sand and gravel was produced in 25 of the 27 counties in western North Carolina. The output from the 25 counties was more than 4 million tons valued at about $4 million. About 51 percent of the production in these counties was washed (tables 3 - 11 and 3 - 17). The 1964 output for western North Carolina was about 3 million tons valued at $3 million.

The average quantity of water used was about 430 gallons per ton, based on washed sand and gravel only. All of the intake water was obtained from streams.

TABLE 3 - 16. - Water requirements for preparation of sand and gravel in the Appalachian region of Tennessee
(All figures are for 1962 unless otherwise specified)

County	Sand and gravel production			Water use (million gallons)							Gallons of water per ton of product2/	Water treatment methods3/	Water disposal (million gallons)		1964 sand and gravel production	
	Quantity (1,000 tons)	Value ($1,000)	Washed (1,000 tons)	Intake water by source					Recircu-lating	Total			Consumed4/	To settling ponds, streams, or mines	Quantity (1,000 tons)	Value ($1,000)
				Purchased	Wells	Mine1/	Stream1/	Total								
Bradley........	(5/)	(5/)	(5/)	-	(5/)	-	(5/)	(5/)	(5/)	(5/)	(5/)	Settle......	(5/)	(5/)	(5/)	(5/)
Cumberland.....	63	96	63	-	-	-	7	7	37	44	700	.....do.....	2	5	53	83
Franklin.......	(5/)	(5/)	(5/)	-	-	-	(5/)	(5/)	(5/)	(5/)	(5/)	.....do.....	(5/)	(5/)	(5/)	(5/)
Greene.........	(5/)	(5/)	(5/)	-	(5/)	-	(5/)	(5/)	(5/)	(5/)	(5/)	.....do.....	(5/)	(5/)	28	42
Grundy.........	72	120	72	-	1	-	3	4	4	8	50	.....do.....	1	3	135	169
Hamilton.......	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Knox...........	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Loudon.........	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Monroe.........	30	44	-	-	-	-	-	-	-	-	-	-	-	-	23	34
Putnam.........	(5/)	(5/)	(5/)	-	-	-	(5/)	(5/)	(5/)	(5/)	(5/)	Settle......	(5/)	(5/)	(5/)	(5/)
Sevier.........	28	30	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Unicoi.........	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Undistributed..	1,141	1,855	239	-	1	-	112	113	79	192	610	Settle......	17	96	1,443	2,328
Total or average6/...	1,334	2,145	374	-	2	-	122	124	120	244	650		20	104	1,682	2,656

1/ Water, if acid, is usually neutralized before use.
2/ Water requirements calculated to nearest 10 gallons.
3/ Intake water, before use, is usually pumped to recirculating pond or tank.
4/ Water lost by evaporation or retained in the washed product.
5/ Included in "Undistributed" to avoid disclosing individual operations.
6/ Excludes Cannon County added to Appalachia by PL 90-103.

TABLE 3 - 17. - Water requirements for preparation of sand and gravel in the Appalachian region of North Carolina
(All figures are for 1962 unless otherwise specified)

County	Sand and gravel production			Water use (million gallons)							Gallons of water per ton of product2/	Water treatment methods3/	Water disposal (million gallons)		1964 sand and gravel production	
	Quantity (1,000 tons)	Value ($1,000)	Washed (1,000 tons)	Intake water by source					Recirculating	Total			Consumed4/	To settling ponds, streams, or mines	Quantity (1,000 tons)	Value ($1,000)
				Purchased	Wells	Mine1/	Stream1/	Total								
Alexander......	46	16	-	-	-	-	-	-	-	-	-	-	-	-	43	17
Alleghany......	77	64	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ashe...........	111	131	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Avery..........	-	-	-	-	-	-	-	-	-	-	-	-	-	-	58	45
Buncombe.......	928	983	928	-	-	-	691	691	-	691	750	Settle......	70	621	(5/)	(5/)
Burke..........	277	208	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Caldwell.......	(5/)	(5/)	(5/)	-	-	-	(5/)	(5/)	-	(5/)	(5/)	Settle......	(5/)	(5/)	(5/)	(5/)
Cherokee.......	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	46	37
Davie..........	64	38	-	-	-	-	-	-	-	-	-	-	-	-	158	114
Forsyth........	84	51	84	-	-	-	1	1	1	2	20	Settle......	1	-	117	140
Graham.........	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Haywood........	(5/)	(5/)	(5/)	-	-	-	(5/)	(5/)	(5/)	(5/)	(5/)	Settle......	(5/)	(5/)	(5/)	(5/)
Henderson......	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Jackson........	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Macon..........	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	106	76
Madison........	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
McDowell.......	(5/)	(5/)	(5/)	-	-	-	(5/)	(5/)	-	(5/)	(5/)	Settle......	(5/)	(5/)	(5/)	(5/)
Mitchell.......	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Polk...........	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	114	54
Rutherford.....	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	120	48
Stokes.........	78	47	-	-	-	-	-	-	-	-	-	-	-	-	65	39
Surry..........	19	28	-	-	-	-	-	-	-	-	-	-	-	-	7	11
Transylvania...	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Watauga........	129	122	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Wilkes.........	97	79	-	-	-	-	-	-	-	-	-	-	-	-	111	85
Yadkin.........	9	13	-	-	-	-	-	-	-	-	-	-	-	-	3	5
Yancey.........	365	260	-	-	-	-	-	-	-	-	-	-	-	-	25	36
Undistributed..	2,055	1,898	1,213	-	-	-	(5/)	(5/)	(5/)	267	220	-	28	221	1,760	1,908
Total or average.....	4,339	3,938	2,225	-	-	-	(5/)	(5/)	(5/)	960	430		99	842	2,733	2,615

1/ Water, if acid, is usually neutralized before use.
2/ Water requirements calculated to nearest 10 gallons.
3/ Intake water, before use, is usually pumped to recirculating pond or tank.
4/ Water lost by evaporation or retained in the washed product.
5/ Included in "Undistributed" to avoid disclosing individual operations.

South Carolina

In 1962, the sand and gravel production in western South Carolina was 118,000 tons valued at $118,000. The 1964 production was 169,000 tons valued at $208,000 (table 3 - 11).

There is no Bureau of Mines record of water used to prepare sand and gravel in western South Carolina in 1962.

Georgia

In 1962, the sand and gravel production in northern Georgia was 40,000 tons valued at $47,000. The 1964 output was 1,000 tons valued at $2,000.

The average quantity of water used was 1,150 gallons per ton of washed sand and gravel. The water was obtained from surface sources, principally streams (table 3 - 11).

Alabama

Most of the sand and gravel in northern Alabama is in Recent alluvium and river terrace deposits.

In 1962, about 5 percent of the production of sand and gravel came from 9 of the 33 Appalachian counties in Alabama. The output from these counties was 1.4 million tons, valued at $1.4 million (tables 3 - 11 and 3 - 18).

The average quantity of water used was 200 gallons per ton, based on washed sand and gravel production only. About 30 percent of the total sand and gravel production in the State was washed. All of the intake water used was obtained from surface sources, principally streams.

CRUSHED STONE

Stone of most types is widely distributed in Appalachia. Short hauling distance in many instances is more important to economic usage than mineralogical nature of the stone. For such uses as fill and road material, many types are used interchangeably.

Limestone accounts for 86 percent of the crushed stone produced in Appalachia. In addition to use for aggregate, crushed limestone is used for blast furnace flux, agricultural purposes, lime production, railroad ballast, portland cement, and coal mine dusting. Other kinds of crushed stone also are used for aggregate as well as for riprap, refractory stone, and terrazzo, and to make roofing granules.

TABLE 3 - 18. - Water requirements for preparation of sand and gravel in the Appalachian region of Alabama
(All figures are for 1962 unless otherwise specified)

County	Sand and gravel production			Water use (million gallons)							Gallons of water per ton of product2/	Water treatment methods3/	Water disposal (million gallons)		1964 sand and gravel production	
	Quantity (1,000 tons)	Value ($1,000)	Washed (1,000 tons)	Intake water by source					Recircu- lating	Total			Consumed4/	To settling ponds, streams, or mines	Quantity (1,000 tons)	Value ($1,000)
				Purchased	Wells	Mine1/	Stream1/	Total								
Calhoun........	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cherokee.......	2	4	-	-	-	-	-	-	-	-	-	-	-	-	36	45
Chilton........	(5/)	(5/)	(5/)	-	-	-	(5/)	(5/)	(5/)	(5/)	(5/)	Settle......	(5/)	(5/)	(5/)	(5/)
Cleburne.......	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9	11
Elmore.........	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Etowa..........	-	-	-	-	-	-	-	-	-	-	-	-	-	-	140	202
Franklin.......	(5/)	(5/)	(5/)	-	-	-	(5/)	(5/)	(5/)	(5/)	(5/)	Settle......	(5/)	(5/)	(5/)	(5/)
Jefferson......	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Morgan.........	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Talladega......	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tuscaloosa.....	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Undistributed..	1,386	1,362	419	-	-	-	11	11	72	83	200	Settle......	2	9	1,494	1,710
Total or average6/...	1,388	1,366	419	-	-	-	11	11	72	83	200		2	9	1,679	1,968

1/ Water, if acid, is usually neutralized before use.
2/ Water requirements calculated to nearest 10 gallons.
3/ Intake water, before use, is usually pumped to recirculating pond or tank.
4/ Water lost by evaporation or retained in the washed product.
5/ Included in "Undistributed" to avoid disclosing individual operations.
6/ Excludes counties added to Appalachia by PL 90-103.

Excavation and Preparation

After the overburden is removed, the stone is drilled and blasted. The broken stone on the quarry floor is loaded into trucks with power shovels, draglines, or highlifts. It is transported out of the quarry to a crusher; the crushed stone is screened and sized, and some is prepared in standard washing equipment. Less water is needed for washing stone than for washing sand and gravel, because crushed stone normally does not contain much silt and clay.

Water Use

More than 7.2 billion gallons of water was used to wash about 40 percent of the 82 million tons of crushed stone, valued at $126 million, produced in Appalachia in 1962. The average volume of water was 230 gallons per ton of product, based on washed stone only. The sources of intake water were about 59 percent from surface water, principally streams, 40 percent from ground water, and 1 percent purchased from external sources. After use, the water was pumped to settling basins for removal of solids (table 3 - 19).

Water Quality

The stone industry has no formal specifications or standards for the quality of water used to prepare crushed stone. However, wash water must be free of floating solids when the stone must meet State and Federal roadbuilding specifications for use in concrete. The wash water must also be free of acid or alkaline impurities that might attack the stone or cause corrosion of washing, crushing, and screening equipment.

New York

Production of crushed stone in the Appalachian region of New York normally was sold locally for concrete, road construction, and other purposes. The quarried stones were predominantly limestone and sandstone. In 1962, the quantity of stone quarried was 590,000 tons valued at more than $1.1 million. Water use data for 1962 and production data for 1964 were concealed to prevent disclosure of individual company operations (table 3 - 19).

Pennsylvania

Production of crushed stone in the Appalachian region of Pennsylvania normally was sold locally for concrete, road construction, and other uses. The quarried stone was predominantly limestone, with smaller quantities of sandstone, granite, quartzite, and miscellaneous stone. In 1962, the quantity of stone quarried for crushed stone was more than 14.8 million tons valued at more than $27.8 million.

TABLE 3 - 19. - Water requirements for preparation of crushed stone in Appalachia
(All figures are for 1962 unless otherwise specified)

State	Crushed stone production			Water use (million gallons)							Gallons of water per ton of product2/	Water treatment methods3/	Water disposal (million gallons)		1964 crushed stone production	
	Quantity (1,000 tons)	Value ($1,000)	Washed (1,000 tons)	Intake water by source					Recircu-lating	Total			Consumed4/	To settling ponds, streams, or mines	Quantity (1,000 tons)	Value ($1,000)
				Purchased	Wells	Mine1/	Stream1/	Total								
New York.......	590	1,145	(5/)	-	-	-	(5/)	(5/)	(5/)	(5/)	(5/)	Settle......	(5/)	(5/)	(5/)	(5/)
Pennsylvania...	14,833	27,830	5,601	22	1,693	-	157	1,872	518	2,390	430	.....do.....	197	1,675	16,273	27,789
Ohio...........	4,669	7,123	1,652	-	-	-	85	85	148	233	140	.....do.....	13	72	4,656	7,944
West Virginia..	7,506	13,242	2,874	1	145	-	754	900	13	913	320	.....do.....	90	810	7,481	13,105
Maryland.......	1,666	2,178	(5/)	-	-	-	(5/)	(5/)	(5/)	(5/)	(5/)	.....do.....	(5/)	(5/)	(5/)	(5/)
Virginia.......	8,407	12,535	2,075	8	14	4	223	249	-	249	120	.....do.....	25	224	8,801	14,222
Kentucky.......	5,856	8,822	-	-	-	-	-	-	-	-	-	-	-	-	5,356	7,935
Tennessee......	16,265	22,109	2,786	-	-	-	146	146	-	146	50	Settle......	16	130	17,451	23,912
North Carolina.	4,132	5,951	2,791	-	-	-	327	327	75	402	140	.....do.....	33	294	3,634	5,465
South Carolina.	3,265	4,791	3,230	-	-	-	433	433	810	1,243	390	.....do.....	45	388	3,373	4,667
Georgia........	3,651	6,673	2,531	1	-	-	464	465	162	627	250	.....do.....	47	418	6,434	9,694
Alabama........	11,258	13,803	7,619	12	159	-	213	384	482	866	110	.....do.....	40	344	14,341	17,475
Undistributed..	-	-	841	-	-	-	165	165	2	167	200	.....do.....	16	149	2,410	3,249
Total or average6/...	82,098	126,202	32,000	44	2,011	4	2,967	5,026	2,210	7,236	230		522	4,504	90,210	135,457

1/ Water, if acid, is usually neutralized before use.
2/ Water requirements calculated to nearest 10 gallons.
3/ Intake water, before use, is usually pumped to recirculating pond or tank.
4/ Water lost by evaporation or retained in the washed product.
5/ Included in "Undistributed" to avoid disclosing individual operations.
6/ Excludes counties added to Appalachia by PL 90-103.

About 2.4 billion gallons of water was used to wash 38 percent of the 1962 production. The average quantity of water used was 430 gallons per ton of washed product. The sources of intake water were (1) ground water - 90 percent, (2) surface water - 9 percent, and (3) purchases - 1 percent (tables 3 - 19 and 3 - 20).

Ohio

Production of crushed stone in the Appalachian region of Ohio normally was sold locally for concrete, road construction, and other purposes. The quarried stone was predominantly limestone and sandstone. In 1962, the quantity of crushed stone produced was more than 4.6 million tons valued at more than $7.1 million.

About 233 million gallons of water was used to wash 35 percent of the 1962 production. The average quantity of water used was 140 gallons per ton of washed product. Intake water was obtained entirely from surface water, principally streams (tables 3 - 19 and 3 - 21).

Maryland

Production of crushed stone in the Appalachian region of Maryland in 1962 was about 1.7 million tons valued at about $2.2 million. Water use data for 1962 and production data for 1964 were concealed to prevent disclosure of individual company operations (table 3 - 19).

West Virginia

Most of the crushed stone produced in West Virginia was limestone. Sandstone and miscellaneous stone were also used as crushed stone. Production of crushed stone normally was sold locally. In 1962, the quantity of stone quarried was more than 7.5 million tons valued at more than $13.2 million. In 1964, production was about 7.5 million tons valued at more than $13.2 million.

About 913 million gallons of water was used to wash 38 percent of the 1962 production. The average quantity of water used was 320 gallons per ton of product. The sources of intake water were (1) surface water - 84 percent, (2) ground water - 16 percent, and (3) purchases - negligible (tables 3 - 19 and 3 - 22).

North Carolina

Production of crushed stone in the Appalachian region of North Carolina was more than 4.1 million tons valued at about $6 million in 1962. In 1964, more than 3.6 million tons valued at about $5.5 million was produced. The 1962 tonnage was 5 percent and the 1964 tonnage was 4 percent of the total produced in Appalachia.

About 402 million gallons of water was used to wash 68 percent of the 1962 total tonnage. The average quantity of water used was

TABLE 3 - 20. - Water requirements for preparation of crushed stone in the Appalachian region of Pennsylvania

(All figures are for 1962 unless otherwise specified)

County	Crushed stone production			Water use (million gallons)							Gallons of water per ton of product2/	Water treatment methods3/	Water disposal (million gallons)		1964 crushed stone production	
	Quantity (1,000 tons)	Value ($1,000)	Washed (1,000 tons)	Intake water by source					Recircu-lating	Total			Consumed4/	To settling ponds, streams, or mines	Quantity (1,000 tons)	Value ($1,000)
				Purchased	Wells	Mine1/	Stream1/	Total								
Armstrong......	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	186	432
Bedford........	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Blair..........	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Butler.........	1,186	2,325	(5/)	-	-	-	(5/)	(5/)	(5/)	(5/)	(5/)	Settle......	(5/)	(5/)	(5/)	(5/)
Cambria........	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Carbon.........	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Centre.........	2,028	4,124	1,236	5	-	-	7	12	-	12	10	Settle......	5	7	2,432	4,260
Clarion........	(5/)	(5/)	(5/)	-	-	-	(5/)	(5/)	-	(5/)	(5/)	.....do.....	(5/)	(5/)	(5/)	(5/)
Clinton........	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Elk............	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Fayette........	(5/)	(5/)	(5/)	-	(5/)	-	-	(5/)	-	(5/)	(5/)	Settle......	(5/)	(5/)	(5/)	(5/)
Fulton.........	(5/)	(5/)	(5/)	-	-	-	(5/)	(5/)	(5/)	(5/)	(5/)	.....do.....	(5/)	(5/)	(5/)	(5/)
Huntingdon.....	(5/)	(5/)	(5/)	(5/)	-	-	-	(5/)	-	(5/)	(5/)	.....do.....	(5/)	(5/)	(5/)	(5/)
Jefferson......	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Juniata........	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Lackawanna.....	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Lawrence.......	2,519	4,030	(5/)	-	(5/)	-	-	(5/)	(5/)	(5/)	(5/)	Settle......	(5/)	(5/)	3,200	4,345
Luzerne........	328	533	83	-	-	-	5	5	19	24	290	.....do.....	2	3	(5/)	(5/)
Lycoming.......	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
McKean.........	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Mercer.........	(5/)	(5/)	(5/)	-	(5/)	-	(5/)	(5/)	(5/)	(5/)	(5/)	Settle......	(5/)	(5/)	(5/)	(5/)
Mifflin........	(5/)	(5/)	(5/)	(5/)	(5/)	-	(5/)	(5/)	-	(5/)	(5/)	.....do.....	(5/)	(5/)	(5/)	(5/)
Monroe.........	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Montour........	(5/)	(5/)	(5/)	-	(5/)	-	-	(5/)	-	(5/)	(5/)	Settle......	(5/)	(5/)	(5/)	(5/)
Northumberland.	49	86	-	-	-	-	-	-	-	-	-	-	-	-	55	98
Perry..........	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Schuylkill.....	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Snyder.........	(5/)	(5/)	(5/)	-	(5/)	-	-	(5/)	-	(5/)	(5/)	Settle......	(5/)	(5/)	(5/)	(5/)
Somerset.......	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Susquehanna....	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Union..........	(5/)	(5/)	(5/)	-	(5/)	-	-	(5/)	-	(5/)	(5/)	Settle......	(5/)	(5/)	(5/)	(5/)
Washington.....	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Wayne..........	92	131	-	-	-	-	-	-	-	-	-	-	-	-	155	256
Westmoreland...	649	1,085	(5/)	-	(5/)	-	-	(5/)	(5/)	(5/)	(5/)	Settle......	(5/)	(5/)	665	1,153
Undistributed..	7,982	15,516	4,282	17	1,693	-	145	1,855	499	2,354	550	.....do.....	190	1,665	9,580	17,245
Total or average.....	14,833	27,830	5,601	22	1,693	-	157	1,872	518	2,390	430		197	1,675	16,273	27,789

1/ Water, if acid, is usually neutralized before use.
2/ Water requirements calculated to nearest 10 gallons.
3/ Intake water, before use, is usually pumped to recirculating pond or tank.
4/ Water lost by evaporation or retained in the washed product.
5/ Included in "Undistributed" to avoid disclosing individual operations.

TABLE 3 - 21. - Water requirements for preparation of crushed stone in the Appalachian region of Ohio
(All figures are for 1962 unless otherwise specified)

County	Crushed stone production			Water use (million gallons)							Gallons of water per ton of product2/	Water treatment methods3/	Water disposal (million gallons)		1964 crushed stone production	
	Quantity (1,000 tons)	Value ($1,000)	Washed (1,000 tons)	Intake water by source					Recircu- lating	Total			Consumed4/	To settling ponds, streams, or mines	Quantity (1,000 tons)	Value ($1,000)
				Purchased	Wells	Mine1/	Stream1/	Total								
Adams..........	533	788	(5/)	-	-	-	(5/)	(5/)	(5/)	(5/)	-	Settle......	(5/)	(5/)	690	964
Athens.........	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	167	319
Belmont........	28	66	-	-	-	-	-	-	-	-	-	-	-	-	80	166
Brown..........	39	50	-	-	-	-	-	-	-	-	-	-	-	-	42	56
Coshocton......	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Gallia.........	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Guernsey.......	172	286	-	-	-	-	-	-	-	-	-	-	-	-	70	110
Harrison.......	162	266	-	-	-	-	-	-	-	-	-	-	-	-	123	195
Highland.......	416	611	(5/)	-	-	-	(5/)	(5/)	-	(5/)	-	Settle......	(5/)	(5/)	(5/)	(5/)
Holmes.........	41	124	-	-	-	-	-	-	-	-	-	-	-	-	38	113
Jackson........	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Lawrence.......	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	746	1,363
Monroe.........	-	-	-	-	-	-	-	-	-	-	-	-	-	-	11	18
Morgan.........	100	120	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Muskingum......	1,247	1,325	(5/)	-	-	-	(5/)	(5/)	(5/)	(5/)	-	Settle......	(5/)	(5/)	1,065	1,724
Noble..........	167	292	-	-	-	-	-	-	-	-	-	-	-	-	168	298
Perry..........	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Pike...........	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Ross...........	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Scioto.........	(5/)	(5/)	(5/)	-	-	-	(5/)	(5/)	(5/)	(5/)	-	Settle......	(5/)	(5/)	(5/)	(5/)
Tuscarawas.....	40	77	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Vinton.........	31	72	-	-	-	-	-	-	-	-	-	-	-	-	37	77
Undistributed..	1,693	3,046	1,652	-	-	-	85	85	148	233	140	Settle......	13	72	1,419	2,541
Total or average.....	4,669	7,123	1,652	-	-	-	85	85	148	233	140		13	72	4,656	7,944

1/ Water, if acid, is usually neutralized before use.
2/ Water requirements calculated to nearest 10 gallons.
3/ Intake water, before use, is usually pumped to recirculating pond or tank.
4/ Water lost by evaporation or retained in the washed product.
5/ Included in "Undistributed" to avoid disclosing individual operations.

TABLE 3 - 22. - Water requirements for preparation of crushed stone in the Appalachian region of West Virginia

(All figures are for 1962 unless otherwise specified)

County	Crushed stone production			Water use (million gallons)							Gallons of water per ton of product2/	Water treatment methods3/	Water disposal (million gallons)		1964 crushed stone production	
	Quantity (1,000 tons)	Value ($1,000)	Washed (1,000 tons)	Intake water by source					Recircu-lating	Total			Consumed4/	To settling ponds, streams, or mines	Quantity (1,000 tons)	Value ($1,000)
				Purchased	Wells	Mine1/	Stream1/	Total								
Barbour........	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Berkeley.......	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	2,143	3,773
Braxton........	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Doddridge......	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Gilmer.........	13	28	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Grant..........	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Greenbrier.....	(5/)	(5/)	(5/)	-	-	-	(5/)	(5/)	-	(5/)	(5/)	Settle......	(5/)	(5/)	(5/)	(5/)
Hampshire......	42	75	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hardy..........	10	22	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Harrison.......	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Jefferson......	(5/)	(5/)	(5/)	-	(5/)	-	(5/)	(5/)	(5/)	(5/)	(5/)	Settle......	(5/)	(5/)	(5/)	(5/)
Kanawha........	40	121	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Lewis..........	20	48	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Mercer.........	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Mineral........	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Monongalia.....	(5/)	(5/)	(5/)	(5/)	(5/)	-	(5/)	(5/)	-	(5/)	(5/)	Settle......	(5/)	(5/)	(5/)	(5/)
Nicholas.......	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	2	8
Pendleton......	116	285	107	-	-	-	(5/)	(5/)	-	(5/)	10	Settle......	-	1	182	569
Pocahontas.....	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	97	180
Preston........	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Raleigh........	4	9	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Randolph.......	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Ritchie........	61	86	(5/)	-	-	-	(5/)	(5/)	-	(5/)	(5/)	Settle......	(5/)	(5/)	-	-
Tucker.........	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Upshur.........	21	44	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Undistributed..	7,179	12,524	2,767	(5/)	(5/)	-	754	(5/)	-	913	330	Settle......	90	809	5,057	8,575
Total or average.....	7,506	13,242	2,874	(5/)	(5/)	-	754	(5/)	(5/)	913	320		90	810	7,481	13,105

1/ Water, if acid, is usually neutralized before use.
2/ Water requirements calculated to nearest 10 gallons.
3/ Intake water, before use, is usually pumped to recirculating pond or tank.
4/ Water lost by evaporation or retained in the washed product.
5/ Included in "Undistributed" to avoid disclosing individual operations.

140 gallons per ton of product. Intake value was obtained entirely from surface sources, principally streams (tables 3 - 19 and 3 - 23).

South Carolina

In 1962, the crushed stone production in the Appalachian region of South Carolina was about 3.3 million tons valued at about $4.8 million. The 1964 tonnage was about 3.4 million tons valued at about $4.7 million. Both the 1962 and 1964 tonnages were about 4 percent of total production in Appalachia.

About 1.2 billion gallons of water was used to wash 99 percent of the 1962 tonnage. The average quantity of water used was 390 gallons per ton of product. Intake water was obtained entirely from surface sources, principally streams (table 3 - 19).

Kentucky

In 1962, about 5.9 million tons of crushed stone valued at $8.8 million was produced in the Appalachian region of Kentucky. The 1964 production was about 5.4 million tons valued at $7.9 million. The 1962 tonnage was 7 percent and the 1964 tonnage was 6 percent of the Appalachia total.

Bureau of Mines records contain no data on water use for crushed stone production in Kentucky (table 3 - 19).

Tennessee

Much of the crushed stone in the Appalachian region of Tennessee was produced from limestone. Other stone quarried and crushed included sandstone and miscellaneous rock. In 1962, the quantity of stone crushed was about 16.3 million tons valued at $22.1 million. The 1964 production was about 17.5 million tons valued at about $23.9 million. The 1962 tonnage was about 20 percent and the 1964 tonnage was 19 percent of the Appalachia total.

About 146 million gallons of water was used to wash 17 percent of the 1962 tonnage. The average quantity of water used was 50 gallons per ton of product. The intake water was obtained entirely from surface sources, principally streams (tables 3 - 19 and 3 - 24).

Virginia

In 1962, the quantity of crushed stone produced in the Appalachian region of Virginia was more than 8.4 million tons valued at more than $12.5 million. The tonnage was about 10 percent of the total production in Appalachia. The 1964 crushed stone production was 8.8 million tons valued at more than $14.2 million (tables 3 - 19 and 3 - 25).

TABLE 3 - 23. - Water requirements for preparation of crushed stone in the Appalachian region of North Carolina

(All figures are for 1962 unless otherwise specified)

County	Crushed stone production			Water use (million gallons)							Gallons of water per ton of product2/	Water treatment methods3/	Water disposal (million gallons)		1964 crushed stone production	
	Quantity (1,000 tons)	Value ($1,000)	Washed (1,000 tons)	Intake water by source					Recircu-lating	Total			Consumed4/	To settling ponds, streams, or mines	Quantity (1,000 tons)	Value ($1,000)
				Purchased	Wells	Mine1/	Stream1/	Total								
Alleghany......	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Buncombe.......	(5/)	(5/)	(5/)	-	-	-	(5/)	(5/)	-	(5/)	(5/)	Settle......	(5/)	(5/)	(5/)	(5/)
Caldwell.......	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Cherokee.......	(5/)	(5/)	(5/)	-	-	-	(5/)	(5/)	-	(5/)	(5/)	Settle......	(5/)	(5/)	(5/)	(5/)
Forsyth........	(5/)	(5/)	(5/)	-	-	-	(5/)	(5/)	(5/)	(5/)	(5/)	.....do.....	(5/)	(5/)	(5/)	(5/)
Henderson......	152	306	152	-	-	-	60	60	-	60	400	.....do.....	6	54	186	312
Jackson........	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Macon..........	38	76	38	-	-	-	19	19	-	19	500	Settle......	6	13	126	126
McDowell.......	26	27	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mitchell.......	52	168	-	-	-	-	-	-	-	-	-	-	-	-	60	149
Polk...........	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Stokes.........	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Surry..........	(5/)	(5/)	(5/)	-	-	-	(5/)	(5/)	-	(5/)	(5/)	Settle......	(5/)	(5/)	(5/)	(5/)
Swain..........	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Transylvania...	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Wilkes.........	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Yadkin.........	(5/)	(5/)	(5/)	-	-	-	(5/)	(5/)	(5/)	(5/)	(5/)	Settle......	(5/)	(5/)	(5/)	(5/)
Undistributed..	3,864	5,374	2,601	-	-	-	248	248	75	323	120	.....do.....	21	227	3,262	4,878
Total or average.....	4,132	5,951	2,791	-	-	-	327	327	75	402	140		33	294	3,634	5,465

1/ Water, if acid, is usually neutralized before use.
2/ Water requirements calculated to nearest 10 gallons.
3/ Intake water, before use, is usually pumped to recirculating pond or tank.
4/ Water lost by evaporation or retained in the washed product.
5/ Included in "Undistributed" to avoid disclosing individual operations.

TABLE 3 - 24. - Water requirements for preparation of crushed stone in the Appalachian region of Tennessee
(All figures are for 1962 unless otherwise specified)

County	Crushed stone production			Water use (million gallons)							Gallons of water per ton of product2/	Water treatment methods3/	Water disposal (million gallons)		1964 crushed stone production	
				Intake water by source					Recircu-lating	Total						
	Quantity (1,000 tons)	Value ($1,000)	Washed (1,000 tons)	Purchased	Wells	Mine1/	Stream1/	Total					Consumed4/	To settling ponds, streams, or mines	Quantity (1,000 tons)	Value ($1,000)
Anderson.......	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Blount.........	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	344	491
Bradley........	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Campbell.......	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Carter.........	(5/)	(5/)	(5/)	-	-	-	(5/)	(5/)	-	(5/)	(5/)	Settle......	(5/)	(5/)	(5/)	(5/)
Claiborne......	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	213	286
Clay...........	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	84	126
Cocke..........	41	50	-	-	-	-	-	-	-	-	-	-	-	-	91	95
Coffee.........	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Cumberland.....	390	512	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
De Kalb........	32	32	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fentress.......	134	177	-	-	-	-	-	-	-	-	-	-	-	-	199	271
Franklin.......	859	1,113	914	-	-	-	26	26	-	26	30	Settle......	3	23	766	1,037
Greene.........	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Grundy.........	83	106	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Hamblen........	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	434	592
Hamilton.......	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Hancock........	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Hawkins........	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	136	196
Jefferson......	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Johnson........	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Knox...........	2,688	4,490	-	-	-	-	-	-	-	-	-	-	-	-	2,150	3,075
Macon..........	85	115	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Marion.........	936	1,196	936	-	-	-	9	9	-	9	10	Settle......	1	8	1,152	1,493
McMinn.........	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Meigs..........	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Monroe.........	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Overton........	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Pickett........	36	45	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Putnam.........	420	538	420	-	-	-	1	1	-	1	2	Settle......	-	1	(5/)	(5/)
Rhea...........	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Roane..........	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Sequatchie.....	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Sevier.........	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	239	347
Sullivan.......	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	651	894
Unicoi.........	-	-	-	-	-	-	-	-	-	-	-	-	-	-	130	160
Union..........	9	11	-	-	-	-	-	-	-	-	-	-	-	-	29	35
Warren.........	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Washington.....	203	243	-	-	-	-	-	-	-	-	-	-	-	-	259	324
White..........	323	329	-	-	-	-	-	-	-	-	-	-	-	-	124	124
Undistributed..	10,026	13,152	516	-	-	-	110	110	-	110	200	-	12	98	10,450	14,366
Total or average6/...	16,265	22,109	2,786	-	-	-	146	146	-	146	50		16	130	17,451	23,912

1/ Water, if acid, is usually neutralized before use.
2/ Water requirements calculated to nearest 10 gallons.
3/ Intake water, before use, is usually pumped to recirculating pond or tank.
4/ Water lost by evaporation or retained in the washed product.
5/ Included in "Undistributed" to avoid disclosing individual operations.
6/ Excludes Cannon County added to Appalachia by PL 90-103.

TABLE 3 - 25. - Water requirements for preparation of crushed stone in the Appalachian region of Virginia

(All figures are for 1962 unless otherwise specified)

County	Crushed stone production			Water use (million gallons)							Gallons of water per ton of product2/	Water treatment methods3/	Water disposal (million gallons)		1964 crushed stone production	
	Quantity (1,000 tons)	Value ($1,000)	Washed (1,000 tons)	Intake water by source					Recircu-lating	Total			Consumed4/	To settling ponds, streams, or mines	Quantity (1,000 tons)	Value ($1,000)
				Purchased	Wells	Mine1/	Stream1/	Total								
Alleghany......	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Bath...........	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bland..........	6	8	-	-	-	-	-	-	-	-	-	-	-	-	10	15
Botetourt......	1,888	2,892	-	-	-	-	-	-	-	-	-	-	-	-	2,116	3,217
Giles..........	821	1,322	811	-	-	(5/)	(5/)	(5/)	-	(5/)	(5/)	Settle......	(5/)	(5/)	1,062	2,673
Grayson........	66	88	-	-	-	-	-	-	-	-	-	-	-	-	79	91
Highland.......	-	-	-	-	-	-	-	-	-	-	-	-	-	-	23	31
Lee............	280	460	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Pulaski........	284	377	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Russell........	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Scott..........	630	999	-	-	-	-	-	-	-	-	-	-	-	-	593	927
Smyth..........	(5/)	(5/)	(5/)	8	14	-	15	37	-	37	(5/)	Settle......	4	33	(5/)	(5/)
Tazewell.......	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Washington.....	(5/)	(5/)	(5/)	-	-	-	(5/)	(5/)	-	(5/)	(5/)	Settle......	(5/)	(5/)	762	1,042
Wise...........	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	77	154
Wythe..........	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	1,431	1,587
Undistributed..	4,431	6,388	1,264	-	-	(5/)	(5/)	212	-	212	170	Settle......	21	191	2,648	4,483
Total or average.....	8,407	12,535	2,075	8	14	(5/)	(5/)	249	-	249	120		25	224	8,801	14,220

1/ Water, if acid, is usually neutralized before use.
2/ Water requirements calculated to nearest 10 gallons.
3/ Intake water, before use, is usually pumped to recirculating pond or tank.
4/ Water lost by evaporation or retained in the washed product.
5/ Included in "Undistributed" to avoid disclosing individual operations.

About 249 million gallons of water was used to wash 25 percent of the 1962 production. The average quantity of water used was 120 gallons per ton of product. The sources of intake water were (1) surface water - 89 percent, (2) ground water - 6 percent, (3) purchases - 3 percent, and (4) mines - 2 percent.

Georgia

About 3.7 million tons of crushed stone valued at about $6.7 million was produced in the Appalachian region of Georgia in 1962. The tonnage was about 4 percent of the Appalachia total. The 1964 production was more than 6.4 million tons valued at about $10 million. The 1964 tonnage was 7 percent of the Appalachia total.

About 627 million gallons of water was used to wash 69 percent of the 1962 production. The average quantity of water used was 250 gallons per ton of product. Intake water was obtained entirely from surface sources, principally streams (tables 3 - 19 and 3 - 26).

Alabama

About 11.3 million tons of crushed rock valued at $13.8 million was produced in the Appalachian region of Alabama in 1962. The 1964 production was more than 14.3 million tons valued at about $17.5 million. The 1962 tonnage was 14 percent and the 1964 tonnage was 16 percent of the Appalachia total.

About 866 million gallons of water was used to wash 68 percent of Alabama's 1962 tonnage. The average quantity of water used was 110 gallons per ton of product. The sources of intake water were (1) streams - 56 percent, (2) ground water - 41 percent, and (3) purchased - 3 percent (tables 3 - 19 and 3 - 27).

DIMENSION STONE

About 56 percent of the dimension stone produced in Appalachia in 1964 was sandstone. Other stone quarried included granite, marble, limestone, and miscellaneous stone. Dimension stone was used for monuments, building stone, rubble, flagstone, and curbstone. The stone was quarried in blocks, which were sawn to size and finished by grinding and polishing. The loss in the various operations of quarrying, sawing, and finishing the stone may be as high as 90 percent of the tonnage handled. The waste stone was sometimes sold as crushed stone.

In 1962, dimension stone production for Appalachia was 283,000 tons valued at about $15.7 million. The 1964 production was 327,000 tons valued at $15 million (table 3 - 28).

Water Use

Water was used to prepare about 67 percent of the dimension stone quarried in Appalachia in 1962. About 843 million gallons of

TABLE 3 - 26. - Water requirements for preparation of crushed stone in the Appalachian region of Georgia
(All figures are for 1962 unless otherwise specified)

County	Crushed stone production			Water use (million gallons)							Gallons of water per ton of product[2]	Water treatment methods[3]	Water disposal (million gallons)		1964 crushed stone production	
				Intake water by source					Recircu-lating	Total						
	Quantity (1,000 tons)	Value ($1,000)	Washed (1,000 tons)	Purchased	Wells	Mine[1]	Stream[1]	Total					Consumed[4]	To settling ponds, streams, or mines	Quantity (1,000 tons)	Value ($1,000)
Dade..........	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Douglas........	(5/)	(5/)	(5/)	1	-	-	-	1	2	3	(5/)	Settle......	-	1	(5/)	(5/)
Fannin.........	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Floyd..........	215	377	215	-	-	-	5	5	-	5	30	Settle......	1	4	265	391
Forsyth........	-	-	-	-	-	-	-	-	-	-	-	-	-	-	500	625
Franklin.......	-	-	-	-	-	-	-	-	-	-	-	-	-	-	101	129
Gilmer.........	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Gwinnett.......	(5/)	(5/)	(5/)	-	-	-	1	1	160	161	(5/)	Settle......	-	1	(5/)	(5/)
Hall...........	660	957	660	-	-	-	452	452	-	452	680	.....do.....	45	407	744	1,042
Rabun..........	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Walker.........	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Whitfield......	325	927	325	-	-	-	6	6	-	6	20	Settle......	1	5	1,272	1,524
Undistributed..	2,451	4,412	1,331	-	-	-	-	-	-	-	-	-	-	-	3,552	5,983
Total or average.....	3,651	6,673	2,531	1	-	-	464	465	162	627	250		47	418	6,434	9,694

1/ Water, if acid, is usually neutralized before use.
2/ Water requirements calculated to nearest 10 gallons.
3/ Intake water, before use, is usually pumped to recirculating pond or tank.
4/ Water lost by evaporation or retained in the washed product.
5/ Included in "Undistributed" to avoid disclosing individual operations.

TABLE 3 - 27. - Water requirements for preparation of crushed stone in the Appalachian region of Alabama

(All figures are for 1962 unless otherwise specified)

County	Crushed stone production			Water use (million gallons)							Gallons of water per ton of product2/	Water treatment methods3/	Water disposal (million gallons)		1964 crushed stone production	
	Quantity (1,000 tons)	Value ($1,000)	Washed (1,000 tons)	Intake water by source					Recircu-lating	Total			Consumed4/	To settling ponds, streams, or mines	Quantity (1,000 tons)	Value ($1,000)
				Purchased	Wells	Mine1/	Stream1/	Total								
Bibb..........	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Calhoun........	-	-	-	-	-	-	-	-	-	-	-	-	-	-	400	512
Colbert........	1,146	1,332	1,146	-	-	-	24	24	-	24	20	Settle......	2	22	(5/)	(5/)
Cullman........	-	-	-	-	-	-	-	-	-	-	-	-	-	-	53	79
De Kalb........	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Etowah.........	(5/)	(5/)	(5/)	-	-	-	(5/)	(5/)	(5/)	(5/)	(5/)	Settle......	(5/)	(5/)	(5/)	(5/)
Franklin.......	(5/)	(5/)	(5/)	-	-	-	(5/)	(5/)	-	(5/)	(5/)	.....do.....	(5/)	(5/)	(5/)	(5/)
Jackson........	-	-	-	-	-	-	-	-	-	-	-	-	-	-	110	211
Jefferson......	2,979	3,394	2,118	12	125	-	104	241	61	302	142	Settle......	24	217	3,054	3,384
Limestone......	53	79	-	-	-	-	-	-	-	-	-	-	-	-	70	104
Madison........	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Marshall.......	(5/)	(5/)	(5/)	-	-	-	(5/)	(5/)	(5/)	(5/)	(5/)	Settle......	(5/)	(5/)	(5/)	(5/)
Morgan.........	(5/)	(5/)	(5/)	-	-	-	(5/)	(5/)	(5/)	(5/)	(5/)	.....do.....	(5/)	(5/)	(5/)	(5/)
Shelby.........	3,470	4,851	2,941	-	34	-	12	46	228	274	90	.....do.....	5	41	4,609	6,203
St. Clair......	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Talladega......	(5/)	(5/)	(5/)	-	-	-	(5/)	(5/)	(5/)	(5/)	(5/)	Settle......	(5/)	(5/)	(5/)	(5/)
Tuscaloosa.....	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Undistributed..	3,610	4,147	1,414	-	-	-	73	73	193	266	190	Settle......	9	64	6,045	6,982
Total or average6/...	11,258	13,803	7,619	12	159	-	213	384	482	866	110		40	344	14,341	17,475

1/ Water, if acid, is usually neutralized before use.
2/ Water requirements calculated to nearest 10 gallons.
3/ Intake water, before use, is usually pumped to recirculating pond or tank.
4/ Water lost by evaporation or retained in the washed product.
5/ Included in "Undistributed" to avoid disclosing individual operations.
6/ Excludes counties added to Appalachia by PL 90-103

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DEVELOPMENT OF WATER RESOURCES IN APPALACHIA. VOLUME 24. APPEND--ETC(U)

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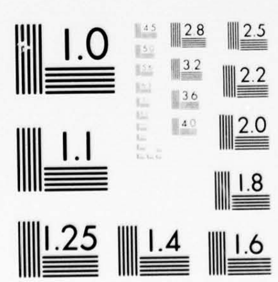


MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

TABLE 3 - 28. - Water requirements for preparation of dimension stone in Appalachia
(All figures are for 1962 unless otherwise specified)

State	Dimension stone production			Water use (million gallons)							Gallons of water per ton of product2/	Water treatment methods3/	Water disposal (million gallons)		1964 dimension stone production	
	Quantity (1,000 tons)	Value ($1,000)	Finished (1,000 tons)	Intake water by source					Recircu-lating	Total			Consumed4/	To settling ponds, streams, or mines	Quantity (1,000 tons)	Value ($1,000)
				Purchased	Wells	Mine1/	Stream1/	Total								
New York.......	35	1,034	35	-	2	-	1	3	18	21	6,000	Settle, chlorinate.	1	2	37	1,004
Pennsylvania...	21	380	-	-	-	-	-	-	-	-	-	-	-	-	44	946
Ohio...........	55	3,495	55	-	2	-	148	150	30	180	3,270	Settle......	15	135	73	2,546
West Virginia..	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Maryland.......	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Tennessee......	(5/)	(5/)	(5/)	-	9	-	26	35	5	40	(5/)	Settle......	5	30	(5/)	(5/)
North Carolina.	(5/)	(5/)	(5/)	-	1	-	352	353	-	353	(5/)	.....do.....	35	318	(5/)	(5/)
Georgia........	(5/)	(5/)	(5/)	-	-	-	249	249	-	249	(5/)	.....do.....	25	224	(5/)	(5/)
Undistributed..	172	10,748	101	-	-	-	-	-	-	-	-	-	-	-	173	10,507
Total or average6/...	283	15,657	191	-	14	-	776	790	53	843	4,410		81	709	327	15,003

1/ Water, if acid, is usually neutralized before use.
2/ Water requirements calculated to nearest 10 gallons.
3/ Intake water, before use, is usually pumped to recirculating pond or tank.
4/ Water lost by evaporation or retained in the washed product.
5/ Included in "Undistributed" to avoid disclosing individual operations.
6/ Excludes counties added to Appalachia by PL 90-103.

water was used to finish this tonnage. The average quantity of water used was about 4,410 gallons per ton of product. Of the total intake water 98 percent was obtained from surface water sources and the remainder from ground-water sources.

Water Quality

The dimension stone industry requires clean water for cutting and finishing operations. The water was usually pretreated before using to assure sediment-free water.

New York

Much of the dimension stone produced in the Appalachian region of New York was sandstone. In 1962, about 35,000 tons valued at $1 million was produced. The 1964 tonnage was 37,000 valued at $1 million. In 1962, about 21 million gallons of water was used. The average quantity of water used was 6,000 gallons per ton of product (table 3 - 28).

Pennsylvania

In 1962, 21,000 tons of dimension stone valued at $380,000 and in 1964, 44,000 tons valued at $946,000, was produced in the Appalachian region of Pennsylvania. There was no Bureau of Mines record of water used in the manufacture of dimension stone in Pennsylvania.

Ohio

In 1962, about 55,000 tons of dimension stone valued at about $3.5 million and in 1964, 73,000 tons valued at more than $2.5 million, was produced from the Appalachian region of Ohio. The 1962 production required 180 million gallons of water. The average quantity of water used was about 3,270 gallons per ton of product.

West Virginia, Maryland, Tennessee, North Carolina, and Georgia

The dimension stone output from the Appalachian region of West Virginia, Maryland, Tennessee, North Carolina, and Georgia was concealed to prevent disclosure of individual company operations (table 3 - 28).

CLAY AND SHALE

Clay is a general name for any plastic, earthy material which can be molded into any desired shape. A few clays, such as flint clay, and many shales are plastic only to a slight degree. Much of the clay and shale produced in Appalachia was used locally for manufacturing building bricks, tile, and other clay products.

About 6.9 million tons of clay and shale valued at about $22 million was produced in Appalachia in 1962. The 1964 tonnage was more than 7.2 million valued at more than $25.2 million. Clay and shale were mined either by underground or surface methods (table 3 - 29.

Water Use

In 1962, about 336 million gallons of water was used to process clay and shale. The average quantity of water used was 49 gallons per ton of material processed. Of this about 46 gallons per ton was used for plasticising the clay and about 3 gallons per ton for miscellaneous uses.

Water Quality

The clay and shale industry has no formal specifications or standards for water quality. The actual quality of water used is excellent, because it is either obtained from wells or specially treated surface water. The water must be free of floating and suspended solids and have a pH between 6 and 8.

New York, West Virginia, Maryland, Virginia, North Carolina, and Georgia

The 1962 and 1964 production and value data for the Appalachian region of New York, West Virginia, Maryland, Virginia, North Carolina, and Georgia were concealed to avoid disclosure of individual company operations (table 3 - 29).

Pennsylvania

About 2.1 million tons of clay and shale valued at $10.1 million was produced in the Appalachian region of Pennsylvania in 1962. The 1964 tonnage was about 2.4 million tons valued at more than $12.5 million.

About 20 million gallons of water was used to process the 1962 production (table 3 - 29).

Ohio

More than 1.9 million tons of clay and shale valued at about $6.4 million was produced in the Appalachian region of Ohio in 1962. The 1964 tonnage was about 2 million valued at more than $7.1 million.

About 9 million gallons of water was used to process the 1962 tonnage (table 3 - 29).

TABLE 3 - 29. - Water requirements for processing clay and shale in Appalachia
(All figures are for 1962 unless otherwise specified)

State	Clay and shale production			Water use (million gallons)							Gallons of water per ton of product2/	Water treatment methods3/	Water disposal (million gallons)		1964 clay and shale production	
	Quantity (1,000 tons)	Value ($1,000)	Processed (1,000 tons)	Intake water by source					Recirculating	Total			Consumed4/	To settling ponds, streams, or mines	Quantity (1,000 tons)	Value ($1,000)
				Purchased	Wells	Mine1/	Stream1/	Total								
New York.......	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Pennsylvania...	2,098	10,099	2,098	2	6	-	2	10	10	20	10	Settle, filter, soften.....	1	9	2,398	12,503
Ohio...........	1,910	6,385	1,910	-	8	-	1	9	-	9	5	.....do.....	1	8	1,955	7,126
West Virginia..	447	(5/)	447	-	-	-	-	-	-	-	-	-	-	-	518	2,316
Maryland.......	(5/)	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Virginia.......	(5/)	(5/)	(5/)	-	-	-	-	-	-	-	-	-	-	-	(5/)	(5/)
Kentucky.......	305	1,313	305	-	2	-	-	2	-	2	10	Settle, filter.....	1	1	229	905
Tennessee......	512	356	512	-	-	-	25	25	-	25	490	.....do.....	5	20	612	420
North Carolina.	(5/)	(5/)	(5/)	-	3	-	81	84	9	93	(5/)	.....do.....	8	76	(5/)	(5/)
Georgia........	(5/)	(5/)	(5/)	1	-	-	-	1	-	1	(5/)	Settle......	-	1	(5/)	(5/)
Alabama........	612	744	612	11	4	-	167	182	4	186	300	Settle, filter.....	18	164	527	838
Undistributed..	1,001	3,175	1,001	-	-	-	-	-	-	-	-	-	-	-	965	1,147
Total or average6/...	6,885	22,072	6,885	14	23	-	276	313	23	336	49		34	279	7,204	25,255

1/ Water, if acid, is usually neutralized before use.
2/ Water requirements calculated to nearest 10 gallons.
3/ Intake water, before use, is usually pumped to recirculating pond or tank.
4/ Water lost by evaporation or retained in the washed product.
5/ Included in "Undistributed" to avoid disclosing individual operations.
6/ Excludes counties added to Appalachia by PL 90-103.

Kentucky

About 305,000 tons of clay and shale valued at more than $1.3 million was produced in the Appalachian region of Kentucky in 1962. The 1964 production was 229,000 tons valued at $905,000.

About 2 million gallons of water was used to process the 1962 tonnage (table 3 - 29).

Tennessee

About 512,000 tons of clay and shale valued at $356,000 was produced in the Appalachian region of Tennessee in 1962. In 1964, about 612,000 tons valued at $420,000 was produced.

About 25 million gallons of water was used to process the 1962 tonnage.

Alabama

About 612,000 tons of clay and shale valued at $744,000 was produced in the Appalachian region of Alabama in 1962. In 1964, the production was 527,000 tons valued at $838,000.

About 186 million gallons of water was used to process the 1962 tonnage (table 3 - 29).

MISCELLANEOUS MINERALS

Miscellaneous minerals produced in the Tennessee, North Carolina, Georgia, and Alabama portions of Appalachia included iron ore, mica, barite, copper, zinc, feldspar, talc, and slate. Individual commodities were concealed to avoid disclosure of individual company confidential data.

About 14 billion gallons of water was used in the processing of the miscellaneous minerals in 1962. The average quantity of water used was 2,750 gallons per ton of product (table 3 - 30).

DISCUSSION

The mineral industry in Appalachia obtained water from several sources. The most important source, accounting for about 66 percent of the total intake, was streams or other surface water supply near the mine or quarry. Many of the industries, especially those that use large quantities, have developed their own water supplies, because it is cheaper to pump water than to buy it.

The coal industry uses large quantities of mine water to wash and prepare coal for the market. When the mine water is acid, it is usually neutralized with lime before it is circulated in the preparation plant.

TABLE 3 - 30. - Water requirements for preparation of miscellaneous minerals 1/ in Appalachia
(All figures are for 1962 unless otherwise specified)

State	Miscellaneous mineral production			Water use (million gallons)							Gallons of water per ton of product 3/	Water treatment methods 4/	Water disposal (million gallons)		1964 miscellaneous mineral production	
	Quantity (1,000 tons)	Value ($1,000)	Washed (1,000 tons)	Intake water by source					Recircu-lating	Total			Consumed 5/	To settling ponds, streams, or mines	Quantity (1,000 tons)	Value ($1,000)
				Purchased	Wells	Mine 2/	Stream 2/	Total								
Tennessee......	79	23,122	79	41	531	-	3,812	4,384	2,972	7,356	93,110	Settle......	384	3,456	112	34,638
North Carolina.	263	2,956	6/2,320	3	-	-	2,408	2,411	90	2,501	1,080	.....do.....	241	2,170	307	2,866
Georgia........	341	3,316	336	577	57	-	141	775	156	931	2,770	.....do.....	78	697	460	4,042
Alabama........	2,222	14,571	6/2,231	218	344	-	1,491	2,053	833	2,886	1,290	.....do.....	205	1,848	1,490	9,260
Total or average 7/...	2,905	43,965	6/4,966	839	932	-	7,852	9,623	4,051	13,674	2,750		908	8,171	2,369	50,806

1/ Miscellaneous minerals include iron ore, mica, barite, copper, zinc, feldspar, talc, and slate. (Feldspar is normally sold in long tons.)
2/ Water, if acid, is usually neutralized before use.
3/ Water requirements calculated to nearest 10 gallons.
4/ Intake water, before use, is usually pumped to recirculating pond or tank.
5/ Water lost by evaporation or retained in the washed product.
6/ Includes minerals produced outside Appalachia, but processed in Appalachia.
7/ Excludes counties added to Appalachia by PL 90-103.

Waste water usually was treated to remove fines before discharging into streams.

The quantity of waste water discharged to the surface water system by the mineral industry is decreasing. Instead of a once-through use of water to wash or prepare minerals, the present trend is to use closed water systems for economical operation and prevention of stream pollution. The new systems have concentrating devices to collect and remove suspended and floating solids from the circulating water. The discharge from a closed system is nominal, only the minimum necessary to remove floating solids; closed systems usually require 10 or 11 percent makeup water.

Preparation or washing plants for coal, sand, gravel, and stone are considered for the purpose of this report to be integrated with the mine or quarry as a unit. Brick plants normally are located as close as possible to the clay mine to reduce freight costs.

The largest mineral industry user of water in Appalachia in 1962 was the bituminous coal industry (table 3 - 31). More than 114 billion gallons of water, or about 60 percent of the water used by the mineral industries, was used to prepare bituminous coal. The next largest users were the anthracite and sand and gravel industries, which used 16 and 12 percent, respectively, of the total water used by the mineral industries in Appalachia.

CONCLUSIONS

Ample water is available from the many surface and ground-water sources in Appalachia to supply the needs of most industries. The daily flow of the 14 major rivers in Appalachia averages at least 150 billion gallons. In 1962, the mineral industry used an average of only 0.5 billion gallons of water per day. Thus the supply of surface water alone far exceeds the mineral industry demands. It should not be assumed from this, however, that sufficient water is available to any mining operation, current or projected, at any given location; constraints on local water use, such as inadequate supply, water pollution, or competition from nonmineral industries, may be the governing factors.

TABLE 3 - 31. - Water requirements for the mineral industry in Appalachia, 1962, by commodity

Commodity	Water used		Use (gallons per ton of product)			Water treatment (million gallons)		Consumed (million gallons)
	Million gallons	Percent of total	Minimum	Maximum	Average	Method	Quantity	
Anthracite............	30,782	16	1,000	2,420	1,880	Settle, neutralize.	30,782	1,510
Bituminous coal........	114,228	60	0	2,200	710	Settle, neutralize, filter.....	114,228	3,211
Sand and gravel........	22,122	12	0	1,530	980	Settle......	22,122	695
Crushed stone..........	7,236	4	0	912	230	.....do.....	7,236	522
Dimension stone........	843	0.5	0	6,000	4,410	.....do.....	843	80
Clay and shale.........	336	0.5	0	-	49	Settle, filter, soften.....	-	34
Miscellaneous minerals.	13,674	7	-	-	2,750	Settle......	13,674	908
Total[1/]..........	189,221	100					188,885	6,960

1/ Excludes counties added to Appalachia by PL 90-103.

PART 4 - SITE EXAMINATION REPORTS

INTRODUCTION

In February 1967, a preliminary list of projects was furnished by the Office of Appalachian Studies. After consultation with representatives of the twelve District offices of the Corps of Engineers, 45 sites were selected for investigation by the Bureau of Mines. The purpose of the studies was to provide analyses of problems relating to mineral resources and the mineral industry arising from proposed water-development projects.

The site investigations were of three types. The Corps of Engineers District offices chose the most suitable type of investigation for each site. Ten proposed water-development project sites having the greatest potential for contribution to the economic and social development of Appalachia were examined in detail. Examinations were to identify the mineral resources in the areas and to determine the effects of the projects on them. In certain instances, in which minerals or associated operations would be involved, estimates were made of the cost of acquiring these properties. Provisional figures arrived at in these evaluations are not intended to be used in negotiating for specific parcels of land but are intended to indicate the order of magnitude of damages or acquisition costs that might be expected for mineral operations and/or resources.

In the second category of site investigations, reconnaissance examinations were made of 11 sites but cost estimates were not required.

In the third category, 14 reports covering 22 sites were prepared from office and library records, without field examinations. Two additional office studies did not involve specific dam and reservoir development. Mineral resources in four of the northern tier counties of Pennsylvania (Bradford, Potter, Susquehanna, and Tioga) were studied to determine the effect on the mineral industry of setting aside this area for recreation. A study also was made of the Coosa River area of Alabama and Georgia to determine the effect on the mineral industry and mineral resources of a proposed extension of the Alabama waterway to include the Coosa River.

The results of each investigation were submitted to the appropriate District Office. Project reports are presented in Part 4 of Appendix I, grouped by Water Subregions, and pertinent references are listed at the end of each report.

SUBREGION A

No sites were investigated in Subregion A.

SUBREGION B

MINERAL RESOURCES
IN
THE PROPOSED GENEGANTSLET RESERVOIR AREA
SUSQUEHANNA RIVER BASIN, N. Y.

by

James R. Boyle[1/]

ABSTRACT

An onsite examination was made by the Bureau of Mines in the proposed Genegantslet Reservoir area to determine mineral resources which would be affected. Sand and gravel was the only mineral resource found and although it has been mined in the past, there has been no production in recent years. The sand and gravel is not used commercially because of its shale content.

PROPOSED WATER DEVELOPMENT PROJECT

The water development project proposed by the U.S. Army Corps of Engineers would be on Genegantslet Creek in Chenango County, N. Y. It is proposed that an earth-type dam be constructed about 1-1/2 miles west of Greene. Major benefits include flood control and low flow augmentation downstream of Greene to Binghamton, and recreation for the Binghamton-Norwich area.

The Bureau of Mines conducted this investigation to determine the mineral resources that would be affected by the proposed reservoir. This investigation was limited to the area encompassed at full pool elevation plus a 300-foot strip measured horizontally and landward of full pool level.

LOCATION

The proposed Genegantslet Reservoir would lie in Chenango County, N. Y. The damsite would be about 1-1/2 miles west of Greene on Genegantslet Creek and about 3 miles from its confluence with the Chenango River. Water would be backed up about 6 miles and would inundate the communities of Genegantslet and Smithville Flats (fig. 4 - 1).

1/ Mining engineer, Knoxville Office of Mineral Resources, Bureau of Mines, U.S. Department of the Interior, Knoxville, Tenn.

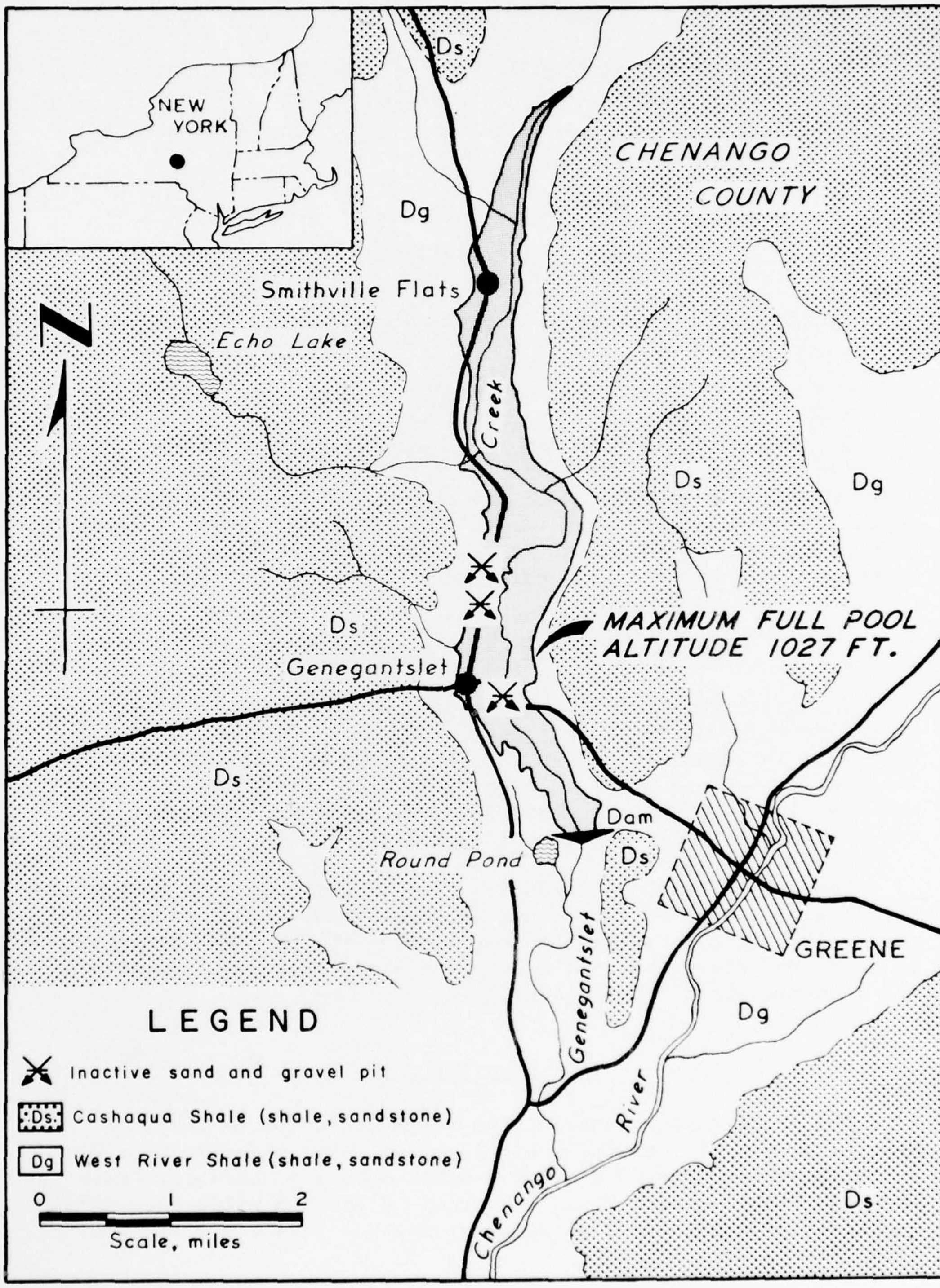


FIGURE 4 - 1. - Location and Geology of the Proposed Genegantslet Reservoir Area, Chenango County, N. Y.

TOPOGRAPHY AND GEOLOGY

The proposed reservoir would lie in a steep sided valley with adjoining hills rising as high as 1,600 feet in altitude. Genegantslet Creek is a relatively small stream of low gradient. Maximum relief in the area is about 700 feet.

The bedrock formations in the proposed reservoir area are Middle or Upper Devonian shales and sandstones. The West River Shale of the Genesee Group underlies the proposed reservoir. The Cashaqua Shale of the Sonyea Group is at a slightly higher elevation on both sides and outside the proposed reservoir.[2/] Glacial deposits of sand and gravel are within the reservoir overlying the bedrock in the valley and on the hillsides.

MINERAL RESOURCES

Sand and gravel has been produced for local consumption, but production has been limited because of the high percentage of shale contained in the material.

Three inactive pits were found within the proposed reservoir area, but they do not appear to have been mined for some time. The proposed reservoir would inundate these inactive pits, but would have little adverse effect on the mineral resources because of poor quality of the sand and gravel and availability of similar deposits in the vicinity that are outside the proposed reservoir.

CONCLUSIONS

Three inactive sand and gravel pits would be inundated, but because of the poor quality of the material and the availability of similar deposits in the vicinity that are outside the proposed reservoir, the project would have little adverse effect on mineral resources.

2/ Broughton, J. G., D. W. Fisher, Y. W. Isachsen, L. V. Rickard, and T. W. Offield. The Geology of New York State. New York State Museum Map and Chart Series 5, 1962, 42 pp.

MINERAL RESOURCES
IN
THE PROPOSED HAWK MOUNTAIN RESERVOIR AREA
DELAWARE RIVER BASIN, N. Y.

by

C. Gordon Leaf[1/]

ABSTRACT

An onsite examination was made of the Hawk Mountain Dam and Reservoir area, proposed by the Philadelphia District, U.S. Army Corps of Engineers, to determine mineral resource involvement. The examination indicated that sand and gravel and stone reserves would be lost as a result of flooding. A number of active sand and gravel pits and two stone finishing plants would be flooded. Compensatory damages would have to be paid for discontinuance or relocation of these operations and for loss of reserves.

PROPOSED WATER DEVELOPMENT PROJECT

The Hawk Mountain project has been proposed by the Philadelphia District, U.S. Army Corps of Engineers for multipurpose development to provide water supply in the Trenton-Philadelphia area, hydroelectric power, and for recreation. The top of the earth and rock fill dam would be 177 feet above the river bed and would have a top length of 1,900 feet. Storage allocations for the project are 60,000 acre-feet of inactive long-term storage, primarily for hydropower, to elevation 1,008 feet and 233,000 acre-feet of active long-term storage for water supply, power, and recreation to elevation 1,082 feet. A total of 7,800 acres would be required for the complete development; 5,800 acres would be for the dam and reservoir and 2,000 acres for directly related recreation. The reservoir, at elevation 1,082 feet would extend upstream 22 miles to about 1 mile west of Downsville, N. Y.

1/ Geologist, Pittsburgh Office of Mineral Resources, Bureau of Mines, U.S. Department of the Interior, Pittsburgh, Pa.

LOCATION

Hawk Mountain dam would be on the East Branch Delaware River about 2-1/2 miles east and upstream from Hancock, N. Y., in Delaware County. The reservoir would lie entirely within Delaware County (fig. 4 - 2).

TOPOGRAPHY AND GEOLOGY

The proposed Hawk Mountain project area is in the Catskill section of the Appalachian Plateau physiographic province. This section is maturely dissected and maximum relief is about 1,500 feet. The principal streams flow in shallow channels in steep-sided, rock-walled, U-shaped valleys.

Bedrock consists of nearly horizontal Devonian sandstone, shale, and siltstone, overlain by unconsolidated sand and gravel of Pleistocene and Recent age. Glacial outwash deposits occur along most of the larger tributary streams and in the valley of the East Branch Delaware River.

MINERAL RESOURCES

Sand and gravel deposits are abundant in the proposed reservoir area and are being mined extensively for use in rebuilding U.S. Highway 17 along East Branch Delaware River and Beaver Kill Creek. A number of these pits would be flooded by the reservoir, but highway construction and operation of these pits probably would be terminated before a reservoir could be constructed. Sand and gravel resources are extensive outside the proposed reservoir area.

Flagstone is being quarried throughout the Hancock-Downsville area. Although no active quarries would be flooded by the reservoir, much stone suitable for flagging would be inundated. Two processing plants and stone yards are in the area that would be flooded, the Tompkins bluestone plant at Tar Hollow and the Johnson and Rhodes Bluestone Company plant at East Branch. These are stone dealers who buy stock from the numerous small quarry operators within a 75-mile radius of their plants. Reserves outside the reservoir area appear to be adequate for future demands.

A crushed stone quarry formerly operated by Cooney Bros., one-half mile west of Tompkins bluestone plant, is above the area which would be flooded. This sandstone quarry is now inactive because the new highway prevents access. Atlantic Coast Aggregates Corp., formerly Cooney Bros., produces crushed sandstone on the southern extension of Hawk Mountain, outside the proposed reservoir area.

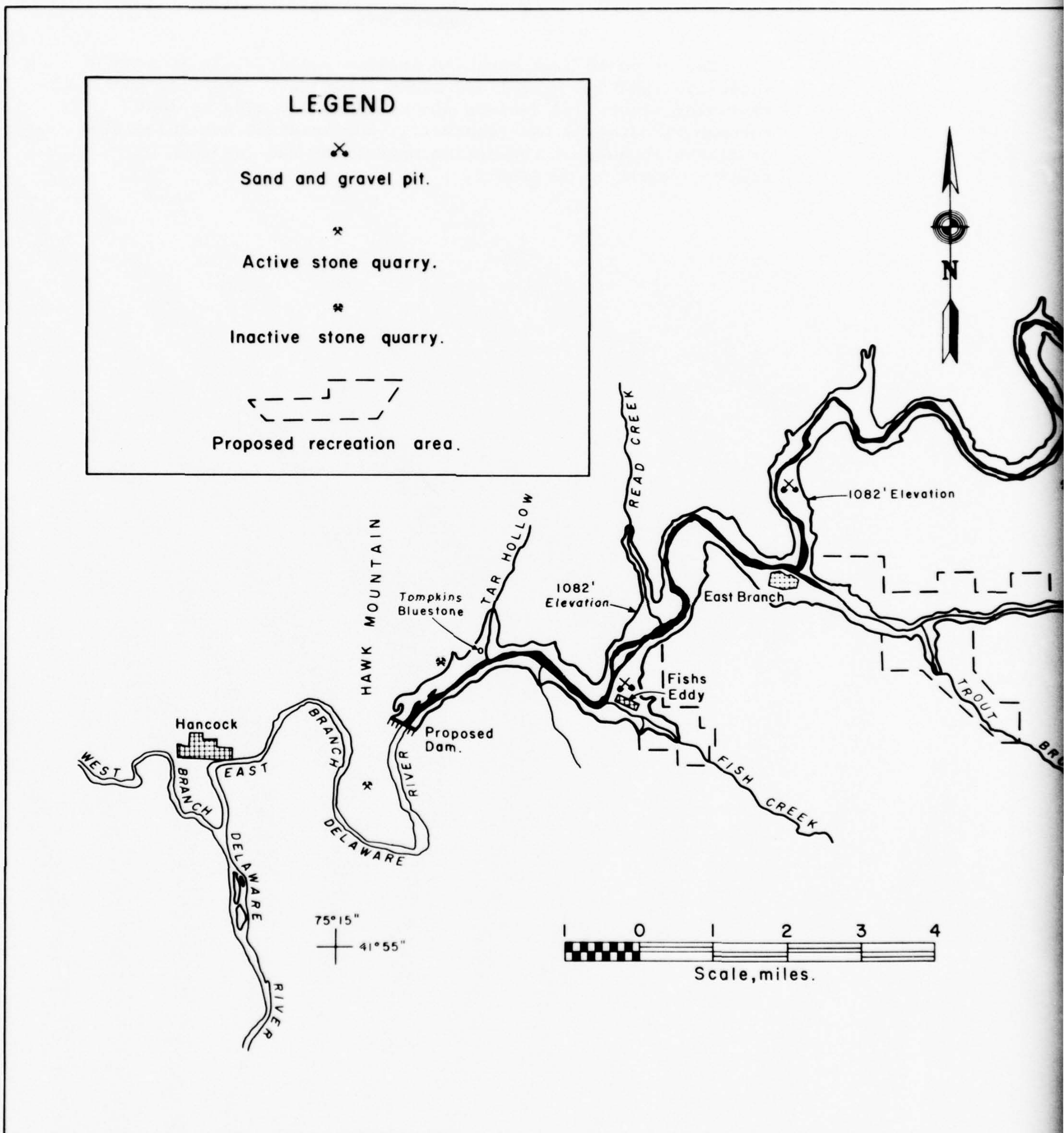
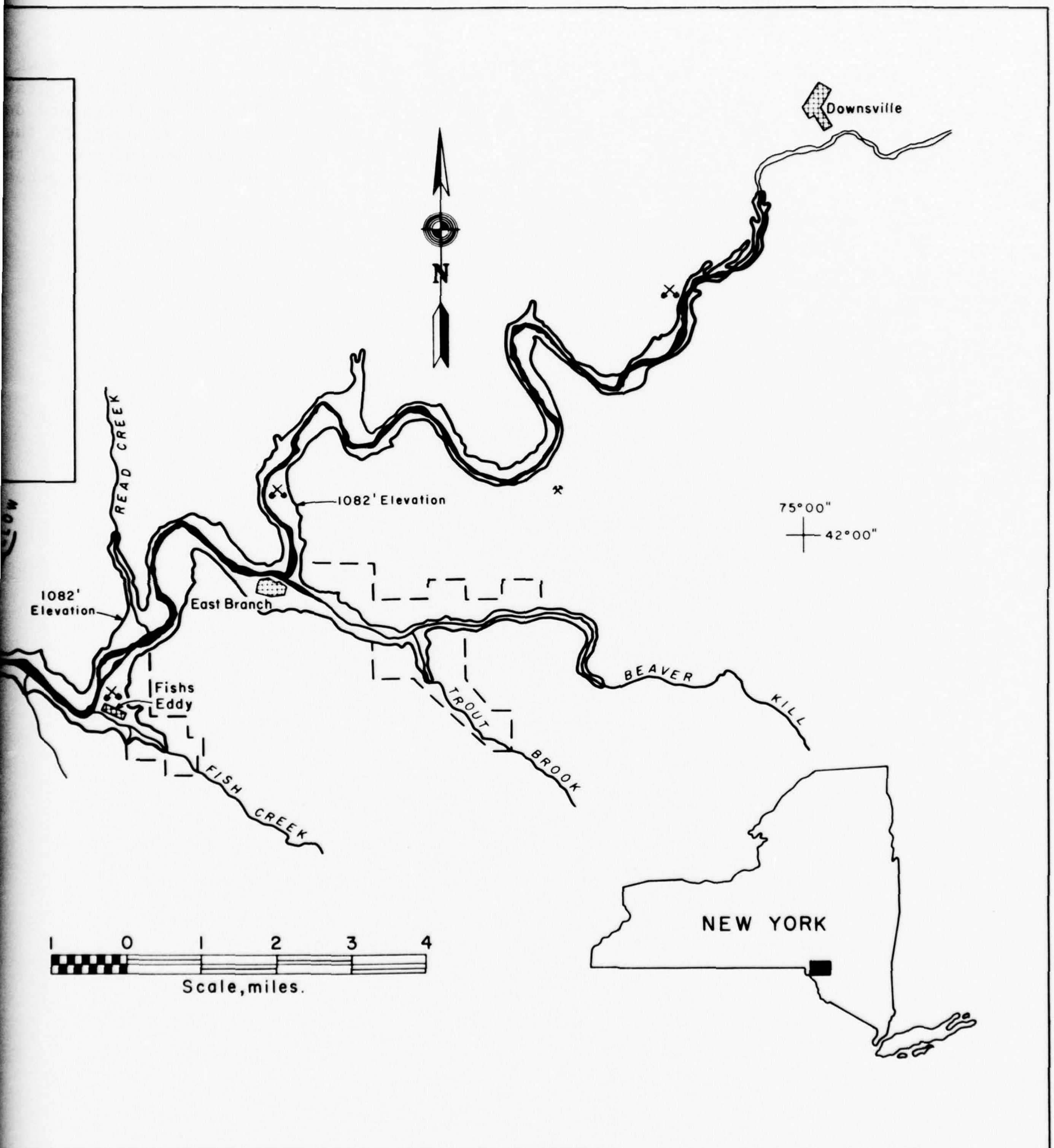


FIGURE 4 - 2. - Proposed Hawk Mountain Dam and Reservoi



URE 4 - 2. - Proposed Hawk Mountain Dam and Reservoir.

CONCLUSIONS

The proposed Hawk Mountain project would result in loss of extensive sand and gravel and stone resources. Two flagstone finishing plants and dealers stockyards would also be lost through flooding by the reservoir. Compensation for relocation or discontinuance of the active operations and for loss of reserves would be necessary.

MINERAL RESOURCES
IN
BRADFORD, POTTER, SUSQUEHANNA,
AND TIOGA COUNTIES, PA.

by

Lawrence Y. Marks[1/]

ABSTRACT

A summary of the major mineral resources of Bradford, Potter, Susquehanna, and Tioga Counties, Pa., was compiled by the Bureau of Mines, U.S. Department of the Interior, largely from published references. Effects of reserving this area for recreation were interpreted from this information. Coal, natural gas and petroleum, stone, and sand and gravel were produced in the area recently. About 31 million tons of bituminous coal, about 2 million tons of anthracite, about 1 million barrels of crude oil, an undetermined quantity of natural gas, and a substantial volume of natural gas storage would be lost. Mineral rights would add to the cost of land acquisition. Potential reserves of rock salt occur in the area. Uranium has been reported and should be considered as a possible source of water pollution.

PURPOSE AND SCOPE

This investigation by the U.S. Bureau of Mines was done at the request of the Baltimore District, U.S. Army Corps of Engineers as part of the study for the development of water resources in Appalachia. A summary of the important mineral resources of Bradford, Potter, Susquehanna, and Tioga Counties was prepared primarily from published information. From this information, conclusions were drawn concerning the effect upon the mineral resources of these counties if the area were reserved for recreation. No field work was undertaken during the course of this study. Principal sources of information used in this report are listed alphabetically at the end of the report.

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PROPOSED WATER DEVELOPMENT

No specific water development projects have been considered in this investigation. Rather, the approach has been to gain some insight to the question which has been raised: "What would be the effects of reserving this four-county area for use only in recreation?" Presumably, several reservoirs would be needed within the area to support recreation. This report deals only with effects related to mineral resources.

LOCATION

Bradford, Potter, Susquehanna, and Tioga Counties are in the northern tier of Pennsylvania counties. Except for the northwestern part of Potter County, the area is in the Susquehanna River Basin (fig. 4 - 3).

TOPOGRAPHY AND GEOLOGY

This group of counties is on the Glaciated Appalachian Plateau. Surface elevations range from less than 700 feet above sea level where the Susquehanna River leaves Bradford County to more than 2,500 feet on some peaks which rise above the broad uplands. Local relief is commonly several hundred feet from upland hills to the bottoms of narrow canyons. Maximum relief occurs at the Grand Canyon of Pennsylvania west of Wellsboro, Pa., in Tioga County where Pine Creek flows through a gorge more than 1,500 feet deep.

Bedrock is of Devonian through Pennsylvanian age. The strata have been warped into a series of northeast trending anticlines and synclines. Dip of the beds is gentle except in southeastern Susquehanna County where rocks dip steeply westward on the flank of a sharp syncline. A description of the bedrock units appears in the legend of figure 4 - 3 (8)[2/].

After a long period of stream erosion, Pleistocene glaciation modified the existing topography. Some hilltops were planed by the glacier and covered with a veneer of till, a poorly sorted mixture of clay, sand, and gravel. Some valleys were filled partially or completely with sorted sand and gravel outwash and with less abundant clay deposits, as the ice sheet melted (1).

Recent streams have reshaped the topography, downcutting the valleys and removing much of the post-glacial debris. Quantities of sand and gravel, reworked from glacial material or eroded from the bedrock surface occur in Recent deposits.

2/ Underlined numbers in parentheses refer to items in the list of references at the end of this report.

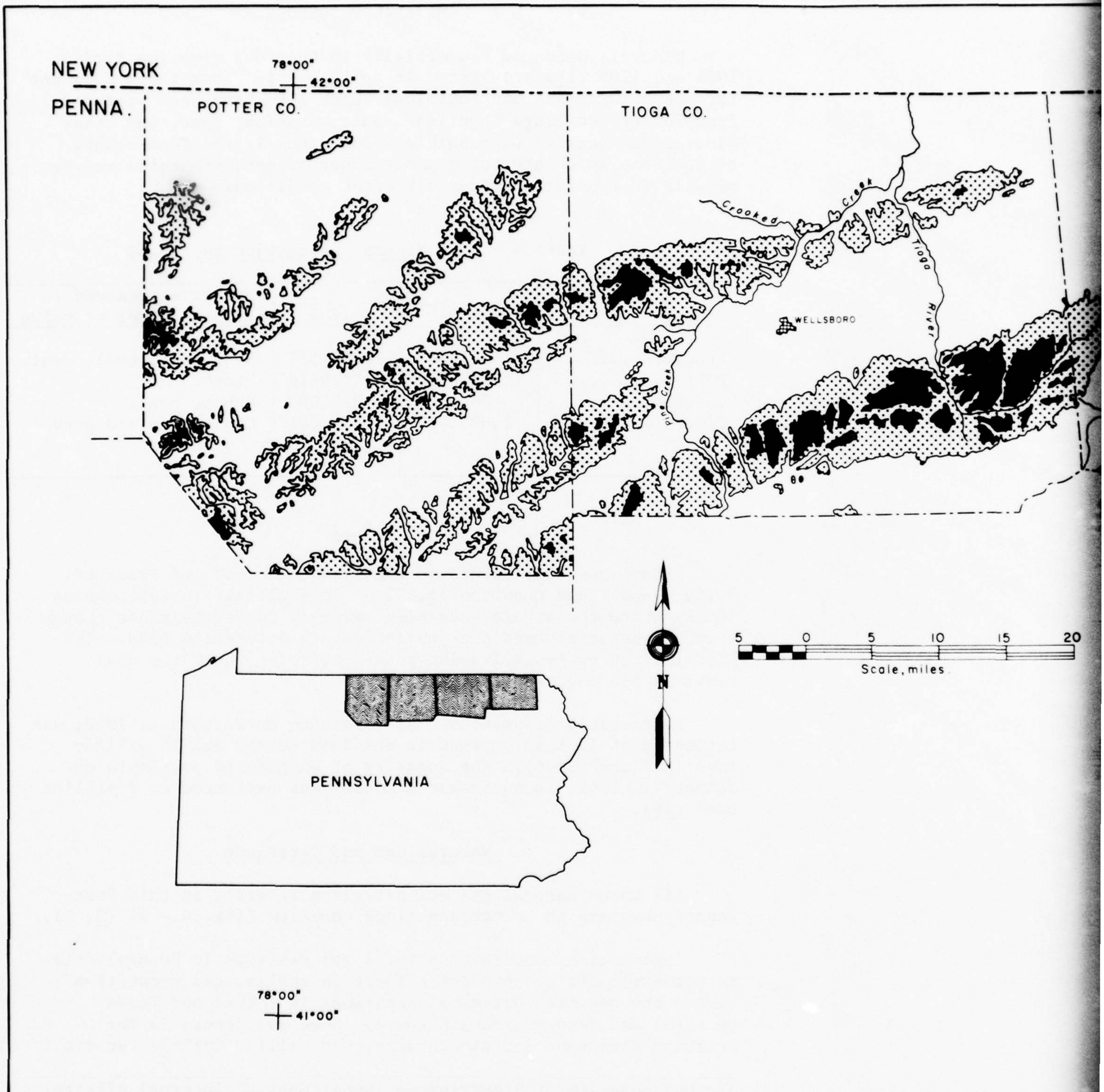

FIGURE 4 - 3. - Geology and Coal Resou
Tioga Counties, Pennsy

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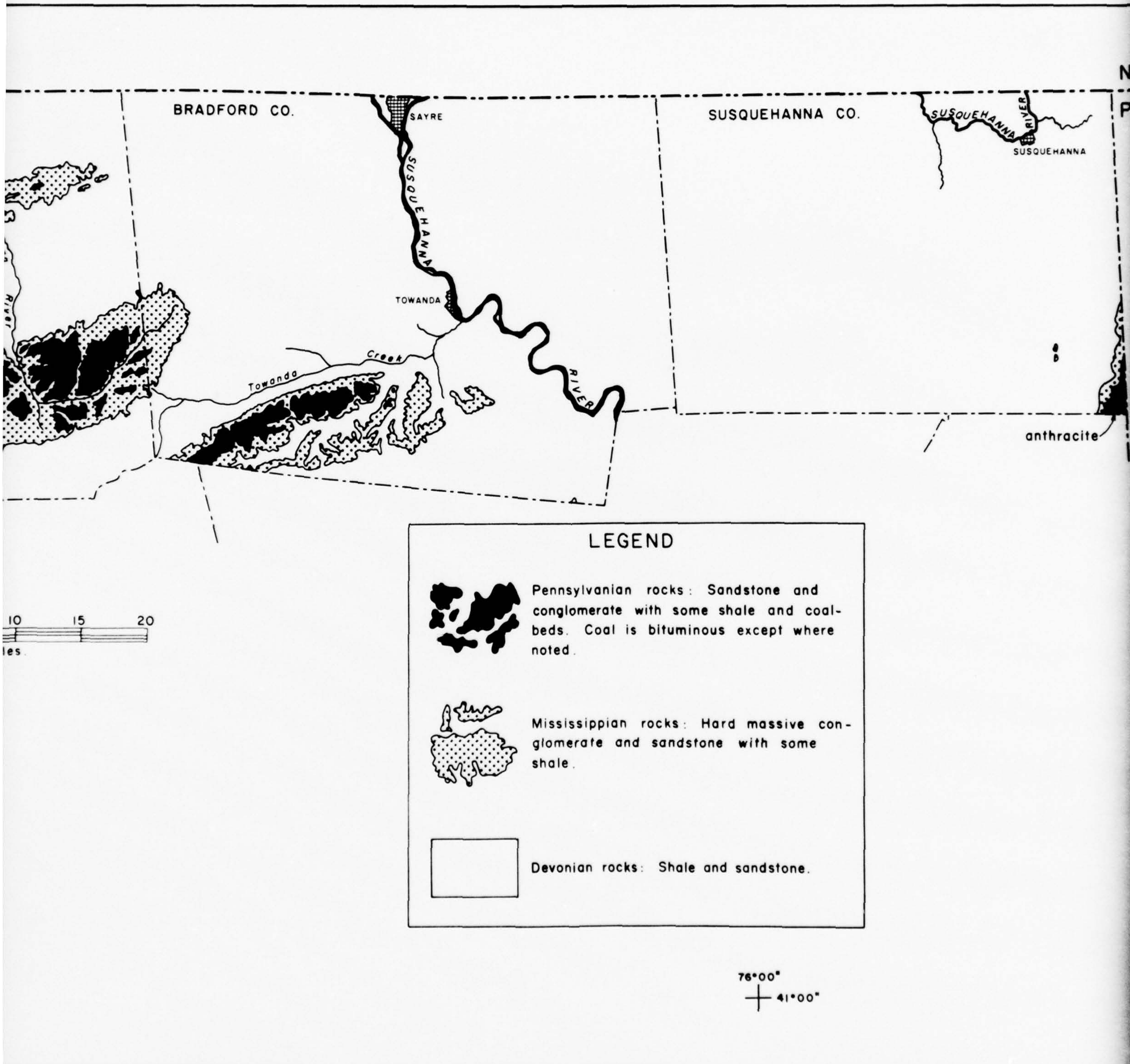
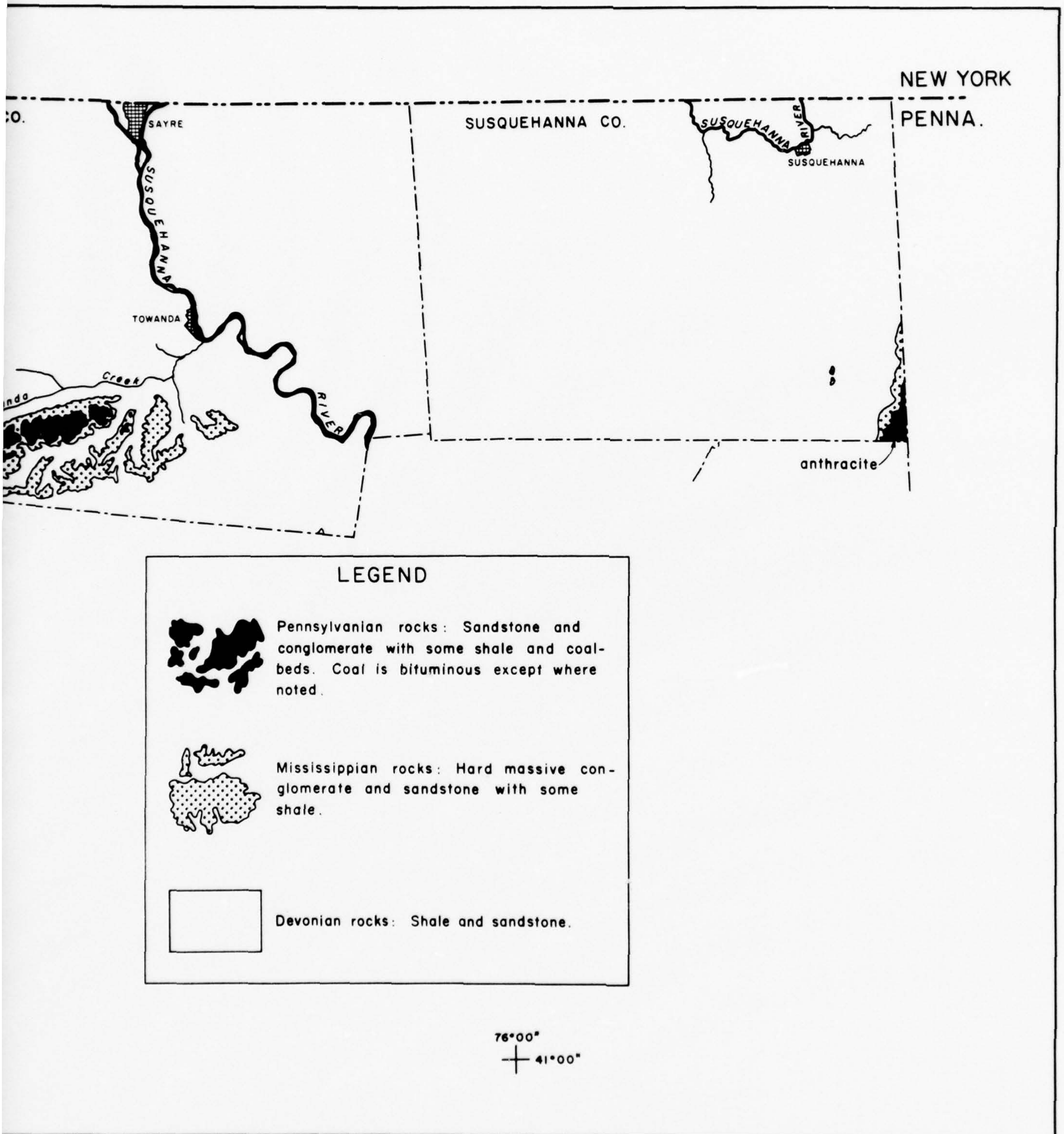


gy and Coal Resources of Bradford, Potter, Susquehanna, and Counties, Pennsylvania. Adapted from References 8 and 14.



dford, Potter, Susquehanna, and
apted from References 8 and 14.

MINERAL RESOURCES

Minerals produced commercially in the four counties during 1964 and 1965 (15) are listed in table 4 - 1. This table does not include natural gas and petroleum which also have been produced from Potter and Tioga Counties. Salt, uranium, peat, and other mineral commodities of possible value occur in the four-county area. Some which are not minable under present economics may be minable in the future under different conditions.

TABLE 4 - 1. - Mineral production by county

County	Value		Minerals produced in 1965 in order of value
	1964	1965	
Bradford.......	$341,185	$389,510	Sand and gravel, coal.
Potter.........	withheld	withheld	Stone.
Susquehanna....	745,587	927,083	Stone, coal.
Tioga..........	1,603,429	1,764,081	Coal, sand and gravel, stone.

Coal

Bituminous coal occurs in Pennsylvanian rocks of Bradford, Potter, and Tioga Counties (8, 11). In southeastern Susquehanna County where the strata have been severely folded, similar though somewhat metamorphosed rock units contain anthracite beds. The distribution of Pennsylvanian rocks indicates where the coal reserves are located (fig. 4 - 3).

Recoverable bituminous coal remaining on January 1, 1963, was estimated at 15 million tons in Bradford County and 16 million tons in Tioga County. The quantity of anthracite available on January 1, 1965, in Susquehanna County was estimated at 2 million tons (14).

Natural Gas and Petroleum

All known natural gas and petroleum reserves in this four-county area are in Potter and Tioga Counties (fig. 4 - 4) (2, 3).

Information concerning natural gas reserves in Pennsylvania is not available by counties. There is shallow gas production (above the Devonian Oriskany Sandstone) in Potter and Tioga Counties and reserves remain there. Some gas occurs in the Oriskany Sandstone and older rocks, but William Lytle3/ reports

3/ Commonwealth of Pennsylvania, Department of Internal Affairs, Bureau of Topographic and Geologic Survey, Pittsburgh, Pa.

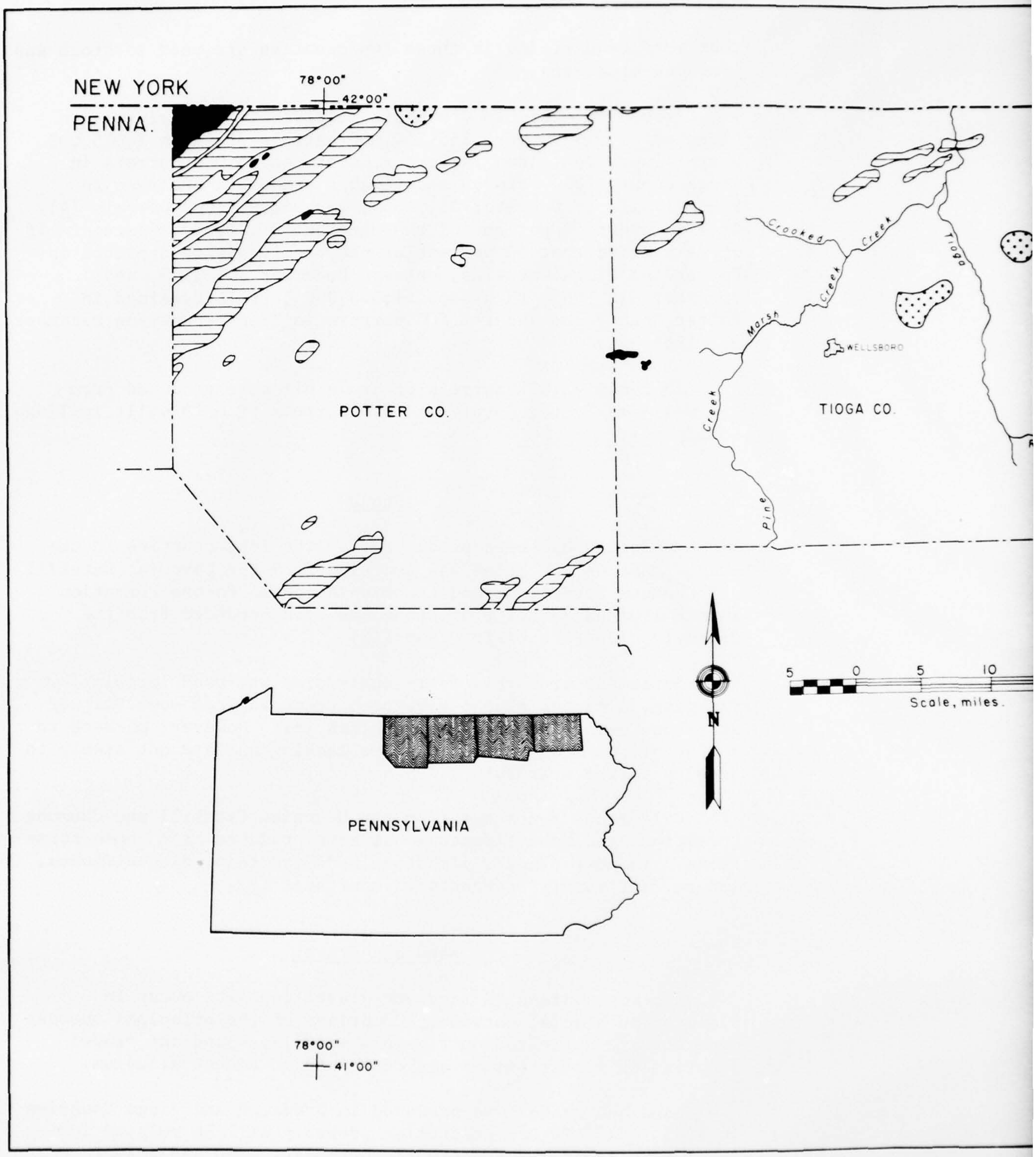
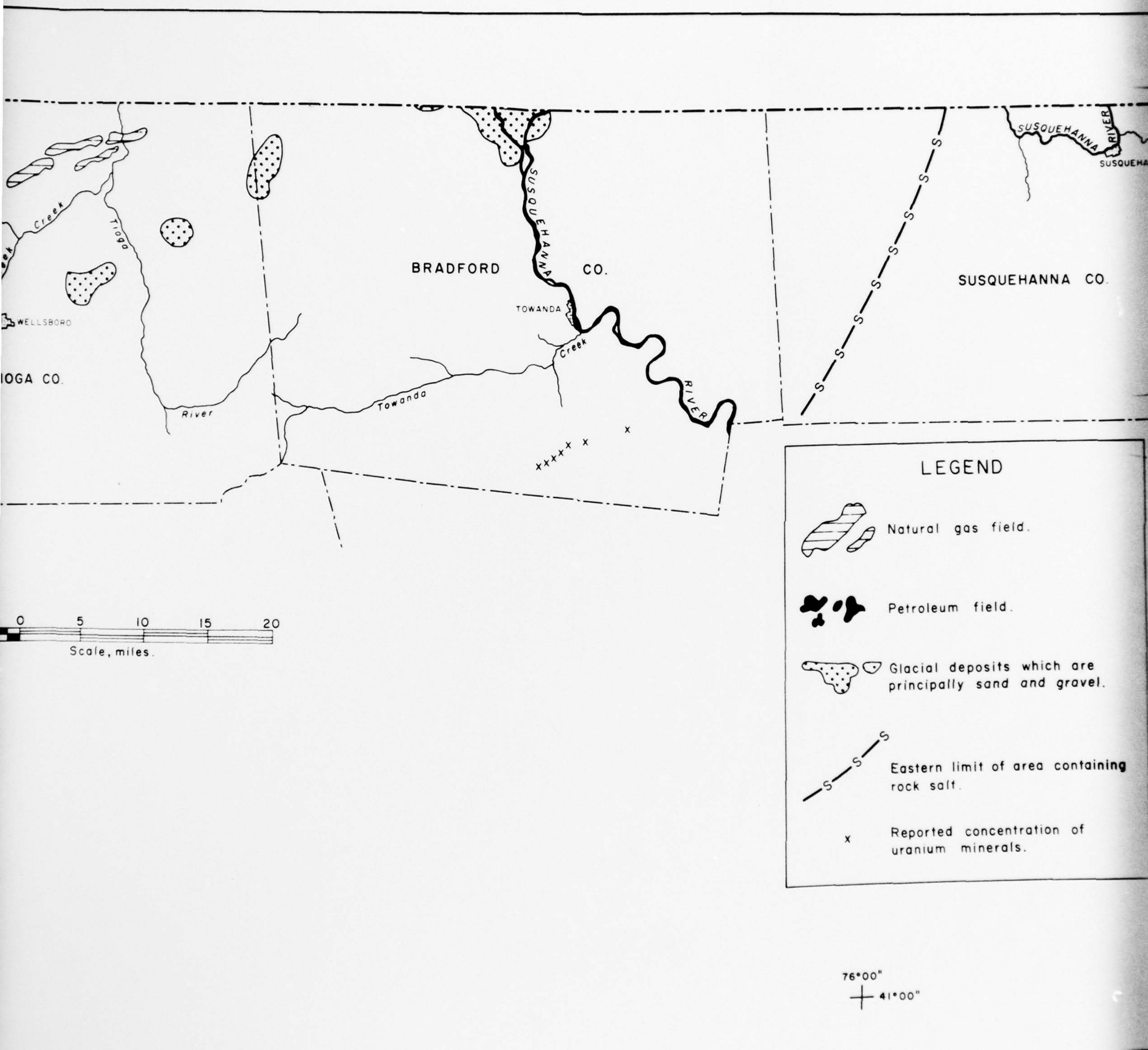


FIGURE 4 - 4. - Natural Ga
Resources
Pennsylvan



- 4. - Natural Gas, Petroleum, Sand and Gravel, Salt, and Uranium Resources of Bradford, Potter, Susquehanna, and Tioga Counties, Pennsylvania. Adapted from References 1 through 6 and 14.

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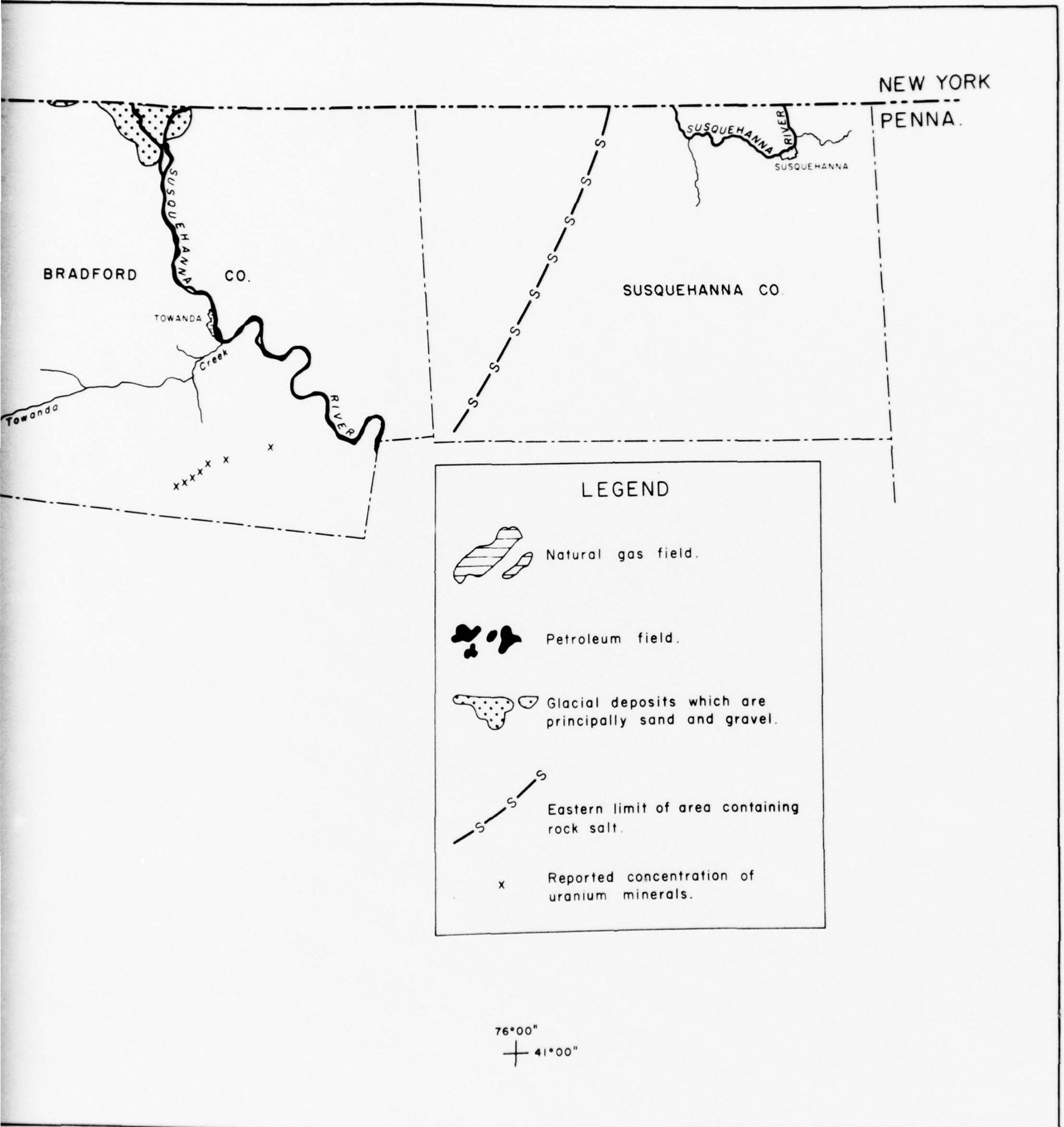

d Gravel, Salt, and Uranium
Susquehanna, and Tioga Counties,
erences 1 through 6 and 14.

that most deep fields in these two counties are used to store gas produced elsewhere.

Proven recoverable crude oil reserves in Pennsylvania on December 31, 1959, were 165,554,000 barrels of which 2,015,000 barrels were contained in Potter County and 5,000 barrels in Tioga County (3). Proven recoverable crude oil reserves in Pennsylvania on December 31, 1965, were 81,865,000 barrels (4). This is about 50 percent of the December 31, 1959, reserves. If it is assumed that 50 percent of the reserves were depleted in Potter and Tioga Counties, between December 31, 1959, and December 31, 1965, then about 1,000,000 barrels remained in Potter County and about 2,500 barrels in Tioga County on December 31, 1965.

In 1964, 42,832 barrels of crude oil were produced from 354 wells in Potter County and 370 barrels from 16 wells in Tioga County (4).

Stone

Sandstone has been produced from the four counties in the area. Most of the stone was quarried from the Devonian Catskill and Chemung Formations and the Mississippian Pocono Formation. A more limited quantity of stone has been produced from the Pennsylvanian Pottsville Group (12).

Sandstone from this four-county area was used largely for flagging, although blocks have been produced from some thicker sandstone beds. Reserves are substantial. However, markets to support large stone operations are lacking and are not likely to develop in the near future.

Calcareous zones occur in the Devonian Catskill and Chemung Formations and some limestone has been produced from these formations. In most places, limestone beds are thin, discontinuous, impure, and rarely of economic importance (7).

Sand and Gravel

The most extensive sand and gravel deposits occur in Pleistocene glacial outwash. Locations of the principal outwash deposits are indicated on figure 4 - 4 (1). Sand and gravel deposits of lesser extent are contained in Recent alluvium.

Sand and gravel was produced in Bradford and Tioga Counties in 1965 (15). Future production probably will be related to local population and construction trends. Sand and gravel ordinarily is not transported more than a few miles to the point of use.

Because the sand and gravel in this four-county area was derived largely from shale and siltstone bedrock, much of it does not meet the rigid strength specifications currently imposed on aggregate to be used for concrete.

Salt

Rock salt occurs in Upper Silurian strata beneath most of the four-county area. The probable extent is indicated in figure 4 - 4 (14). Depth to the salt is more than 5,000 feet in part of Potter County. Twenty-two salt beds totaling 552 feet in thickness were encountered at depths of from 4,424 to 6,508 feet in a hole drilled in Tioga County (13).

Deposits of rock salt in this area are not expected to be exploited in the near future. However, exhaustion of thick salt beds at lesser depth in Ohio and New York might alter economic conditions and lead to production from northern Pennsylvania in the future (14).

Peat

Peat occurs in this four-county area, but no production has been reported in recent years.

Uranium

Minerals containing uranium have been found in Bradford County. All reported occurrences in this county are in the Devonian Catskill Formation. Uranium minerals are concentrated commonly near the bottom of a sandstone channel overlying shale. At each locality, uranium is associated with copper sulfides and carbonates and with coalified wood. Several places in Bradford County where uranium has been reported are shown on figure 4 - 4 (5).

None of the uranium mineralization reported in Pennsylvania is of sufficient grade and extent to be mined profitably. The occurrences in Bradford County contain little uranium; no assay results are available, but radioactivity measurements reported are no higher than a few times the normal background (6).

As little as 40 parts per billion uranium in water is suspected to have killed fish in a Wyoming fishing pond (9, 10). Therefore, in planning a reservoir within an area such as southeastern Bradford County where anomalous radioactivity has been reported, it might be well to consider the likelihood that uranium or other heavy metals may pollute the water. Places

where the Catskill Formation is at the surface appear to be most likely to contribute this kind of pollution.

Low level airborne radiometric surveys, such as those formerly conducted by the U.S. Atomic Energy Commission to prospect for uranium, probably would locate any concentration of radioactive material with sufficient size and proximity to the surface to pollute water in the vicinity.

EFFECT OF WATER DEVELOPMENT ON THE MINERAL INDUSTRY

If this four-county area were withdrawn from use by the mineral industries, the following mineral resources would be affected:

1. About 31 million tons of bituminous coal and about 2 million tons of anthracite would be lost. These quantities are about 1 percent and 0.1 percent of the bituminous coal and anthracite reserves, respectively, of the Susquehanna River Basin (14).

2. About 1 million barrels of crude oil, an undetermined quantity of natural gas, and a substantial volume of natural gas storage would be lost. Unless sufficient storage could be developed in southern New York to replace losses in northern Pennsylvania, lack of storage may present a problem to companies which supply gas to nearby population centers. Reserve figures do not include possible additional discoveries.

3. Substantial reserves of sandstone and sand and gravel would be lost. However, present and predicted markets for these commodities are limited and the loss of material likely to be marketable probably is not great.

4. Reserves of potentially minable rock salt would be lost. Little value can be assigned to the salt at this time because it is not expected to be mined in the near future.

EFFECT OF MINERAL RESOURCES ON WATER DEVELOPMENT

Coal-bearing rocks may contribute acid forming pollutants to streams and reservoirs in areas underlain by or downstream from Pennsylvanian strata.

Concentrations of uranium minerals may pollute surface and ground water locally. The areas where the Devonian Catskill Formation is at the surface contain most of the known uranium mineralization.

CONCLUSIONS

Coal, natural gas, petroleum, stone, and sand and gravel have been produced during recent years in Bradford, Potter, Susquehanna, and Tioga Counties, Pa. Reserves of these commodities would be lost if the four counties were withdrawn from use by the mineral industry. Loss of these reserves would be a small fraction of the total State reserves of these commodities. However, mineral rights would add to the cost of land acquisition.

Rock salt occurs at depth in most of the area, and potentially minable reserves would be lost. However, it is questionable that this salt could be mined in the near future and little value can be placed on it.

Several small low grade concentrations of uranium minerals were reported in Bradford County. Other parts of Pennsylvania, outside the area considered in this report contain known uranium concentrations with characteristics that are more encouraging to prospectors than those in the report area. Therefore, little exploration for uranium is likely to occur in the four-county area. Nevertheless, presence of uranium as a possible source of water pollution should be considered, particularly where reservoirs are planned.

REFERENCES

1. Geological Society of America. Glacial Map of the United States East of the Rocky Mountains. New York, 1959.

2. Jones, T. H., and L. Heeren. Oil and Gas Map of Pennsylvania. Pennsylvania Topographic and Geol. Survey, Harrisburg, Pa., 1953.

3. Lytle, W. S., J. M. Bergsten, A. S. Cate, V. M. Fairall, L. A. Heeren, and W. R. Wagner. A Summary of Oil and Gas Developments in Pennsylvania, 1955 to 1959. Pennsylvania Topographic and Geol. Survey, Bull. M45, Harrisburg, Pa., 1961, 133 pp.

4. Lytle, W. S., J. H. Goth, Jr., D. R. Kelley, W. G. McGlade, and W. R. Wagner. Oil and Gas Developments in Pennsylvania in 1965. Pennsylvania Topographic and Geol. Survey, Progress Report 172, Harrisburg, Pa., 1966, 66 pp.

5. McCauley, J. F. Preliminary Report on the Sedimentary Uranium Occurrences in the State of Pennsylvania. Pennsylvania Topographic and Geol. Survey, Progress Report 152, Harrisburg, Pa., 1957, 22 pp.

6. McCauley, J. F. Uranium in Pennsylvania. Pennsylvania Topographic and Geol. Survey, Bull. M43, Harrisburg, Pa., 1961, 71 pp.

7. Miller, B. L. Limestones in Pennsylvania. Pennsylvania Topographic and Geol. Survey, Bull. M20, Harrisburg, Pa., 1934, 729 pp.

8. Pennsylvania Topographic and Geol. Survey. Geologic Map of Pennsylvania. Harrisburg, Pa., 1960.

9. Post, G. Detoxification Studies on Fishing Waters. Wyoming Game and Fish Commission, Game and Fish Laboratory, Project No. FW-3-R-5, Job Completion Report, Laramie, Wyo., June 30, 1956, 8 pp., unpublished.

10. ______. Detoxification Studies on Fishing Waters. Wyoming Game and Fish Commission, Game and Fish Laboratory, Project No. FW-3-R-5, Job Completion Report, Laramie, Wyo., June 30, 1958, 4 pp., unpublished.

11. Sisler, J. D. Bituminous Coal Fields of Pennsylvania, Part II. Detailed Description of Coal Fields. Pennsylvania Topographic and Geol. Survey, Bull. M6, Harrisburg, Pa., 1961, 511 pp.

12. Stone, R. W. Building Stones of Pennsylvania. Pennsylvania Topographic and Geol. Survey, Bull. M15, Harrisburg, Pa., 1932, 316 pp.

13. ______. The Minerals of Pennsylvania - Nonmetallic Minerals. Pennsylvania Topographic and Geol. Survey, Bull. M18-C, Harrisburg, Pa., 1939, pp. 39-40.

14. Wessel, F. W. Mineral Resources in the Susquehanna River Basin. U.S. BuMines, 1966, 45 pp.

15. Yeloushan, Charles C. The Mineral Industry of Pennsylvania. Ch. in BuMines Minerals Yearbook 1965, v. III, 1967, pp. 679-709.

MINERAL RESOURCES
IN
THE PROPOSED NORTH MOUNTAIN RESERVOIR AREA
POTOMAC RIVER BASIN, W. VA.

by

Vernal A. Danielson[1/]

ABSTRACT

The proposed North Mountain Reservoir site on Back Creek in Berkeley County, W. Va., and Frederick County, Va., was investigated for mineral resource involvement. A literature search and field inspection of the site revealed that no known mineral resources would be affected by the project.

PROPOSED WATER DEVELOPMENT PROJECT

The North Mountain Reservoir proposed by the Corps of Engineers would supplement the streamflow in the Potomac River for municipal water supply and quality control at Washington, D. C., and provide recreation in the Back Creek Valley. An earthfill dam, 1,660 feet long would flood about 3,560 acres at the full conservation pool altitude at 529 feet. Maximum flood pool altitude would be 551 feet.

LOCATION

The proposed dam would be on Back Creek in Berkeley County, W. Va., 2.2 miles south of Jones Springs and 2.3 miles northeast of Shanghai, W. Va. The full conservation pool would extend about 11 miles upstream to DeHaven, in Frederick County, Va. The upper 2 miles of the proposed reservoir would be in Virginia (fig. 4 - 5).

TOPOGRAPHY AND GEOLOGY

Topography within the proposed reservoir site ranges from flat bottom land to steep slopes along the shores. The site lies in the Valley and Ridge province which is characterized by narrow ridges and valleys, with shale predominant in the valleys and the more resistant sandstone forming the ridges. The site itself is underlain by fossiliferous shale and sandstone. Altitudes range from about 500 feet in the valleys to 2,000 feet on the ridges.

1/ Mining engineer, Knoxville Office of Mineral Resources, Bureau of Mines, U.S. Department of the Interior, Knoxville, Tenn.

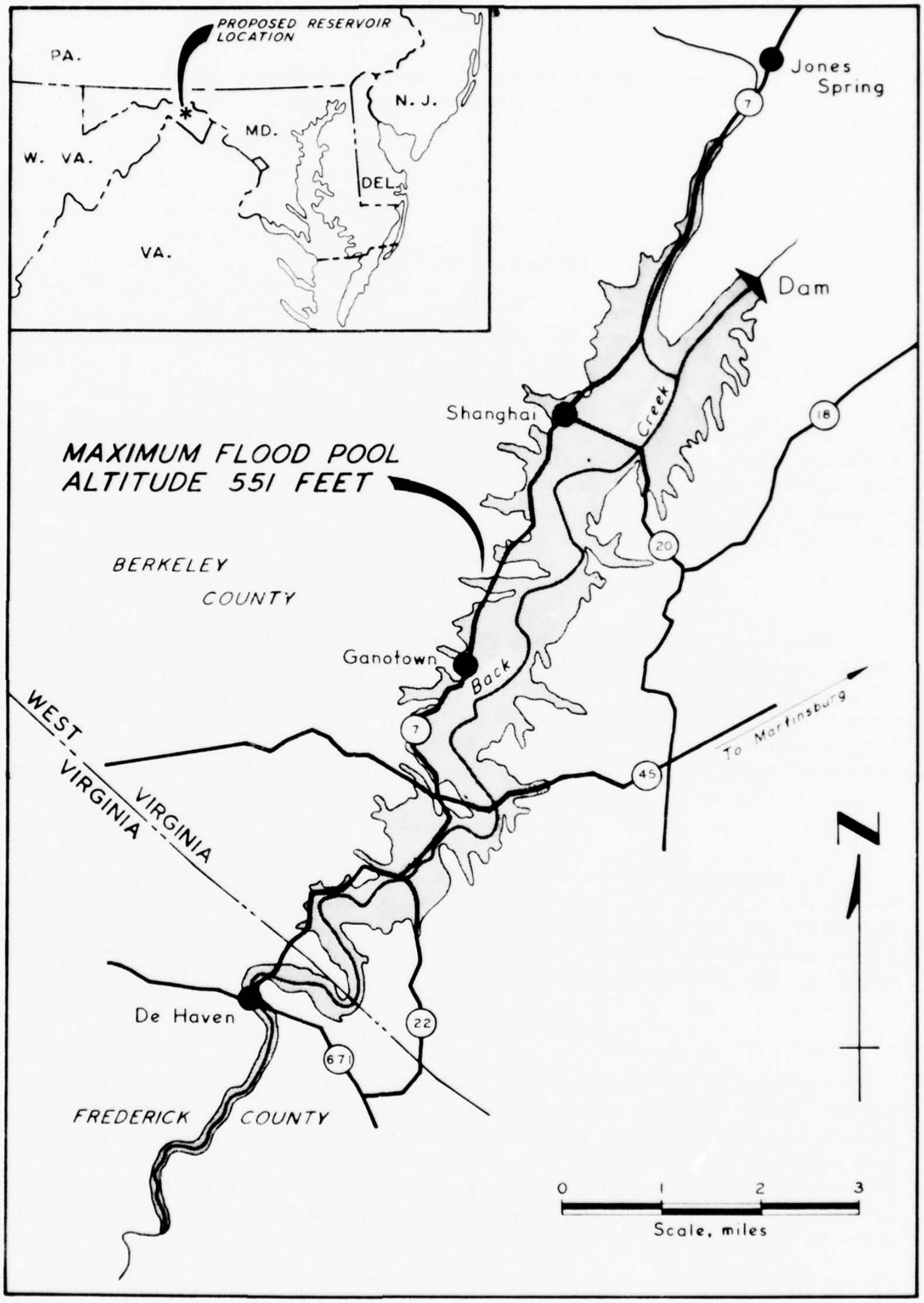

FIGURE 4 - 5. - Location of Proposed North Mountain Reservoir.

MINERAL RESOURCES

There are no active mining operations in the proposed reservoir area. Shale and sandstone, potential sources of construction material, occur in the area. Large quantities of clay and limestone are mined several miles east of Back Creek but none occurs in the proposed reservoir area.

CONCLUSIONS

No economic mineral deposits would be affected by construction of the proposed North Mountain Reservoir. The shale and sandstone in the area might be of use as construction material, but because of their abundance nearby, outside of the reservoir area, no value should be assigned for their mining rights.

MINERAL RESOURCES
IN
THE PROPOSED ROYAL GLEN RESERVOIR AREA
POTOMAC RIVER BASIN, W. VA.

by

Vernal A. Danielson[1/]

ABSTRACT

The proposed Royal Glen Reservoir site on the South Branch of the Potomac River in Grant County, W. Va., was investigated for possible mineral resource involvement. A literature search and field inspection revealed that one active limestone quarry producing crushed limestone for agricultural and construction uses would be partially inundated by the proposed reservoir at maximum flood stage. An undetermined quantity of undeveloped limestone would also be lost.

PROPOSED WATER DEVELOPMENT PROJECT

The Royal Glen Reservoir proposed by the Corps of Engineers would furnish part of the increase in minimum streamflow needed at Washington D. C., for water supply and quality control, provide flood protection for Petersburg, W. Va., and furnish recreation to the upper South Branch valley. A concrete, gravity dam and earth dike would create a reservoir of 1,150 acres at the full conservation pool altitude of 1,060 feet; the maximum flood pool at 1,117 feet would inundate 2,000 acres.

LOCATION

The dam would be constructed on the South Branch of the Potomac River, just downstream of the junction of the North Fork and the South Branch, 3.6 miles due west of Petersburg in Grant County, W. Va. At full conservation pool, the reservoir would extend about 4.4 miles up the South Branch, and about 2.8 miles up the North Fork to the vicinity of North Fork Gap.

TOPOGRAPHY AND GEOLOGY

The proposed reservoir site would be in the Valley and Ridge province of the Appalachian Highlands. This province is characterized by narrow ridges and valleys. The hills surrounding the

1/ Mining engineer, Knoxville Office of Mineral Resources, Bureau of Mines, U.S. Department of the Interior, Knoxville, Tenn.

proposed site rise steeply to altitudes up to 3,000 feet. Rock formations in this area consist of cherty limestones of the Helderberg Formation, overlain by Oriskany Sandstone, with small areas of Romney Shale. The limestone is cavernous in some areas.

MINERAL RESOURCES

One active mineral producer within the proposed reservoir site, Bean's Lime & Stone Co., Moorefield, W. Va., produces crushed limestone for agriculture and construction. The quarry is about 4 miles due west of Petersburg, W. Va., one-third mile north of State Highways 28 and 4 (fig. 4 - 6). Altitude of the quarry floor ranges from about 1,100 to 1,160 feet. The full conservation pool of 1,060 feet would not inundate the quarry floor, but the maximum flood pool altitude of 1,117 feet would result in flooding to depths up to 17 feet.

Compensation for damages might be necessary but estimating the cost is beyond the scope of this report.

Large tonnages of undeveloped limestone, suitable for agriculture and construction, would be inundated. Most of this limestone, however, could not be considered an economic reserve because of lack of accessibility and markets. Sufficient limestone reserves would remain above the flood pool to permit relocation of Bean's Lime & Stone Co. quarry.

CONCLUSIONS

Mineral involvement in the proposed Royal Glen Reservoir site would be limited to occasional inundation of parts of one limestone quarry. It might be feasible to relocate this quarry; further study would be necessary to determine this. Compensation for damages to Bean's Lime & Stone Co. might be necessary.

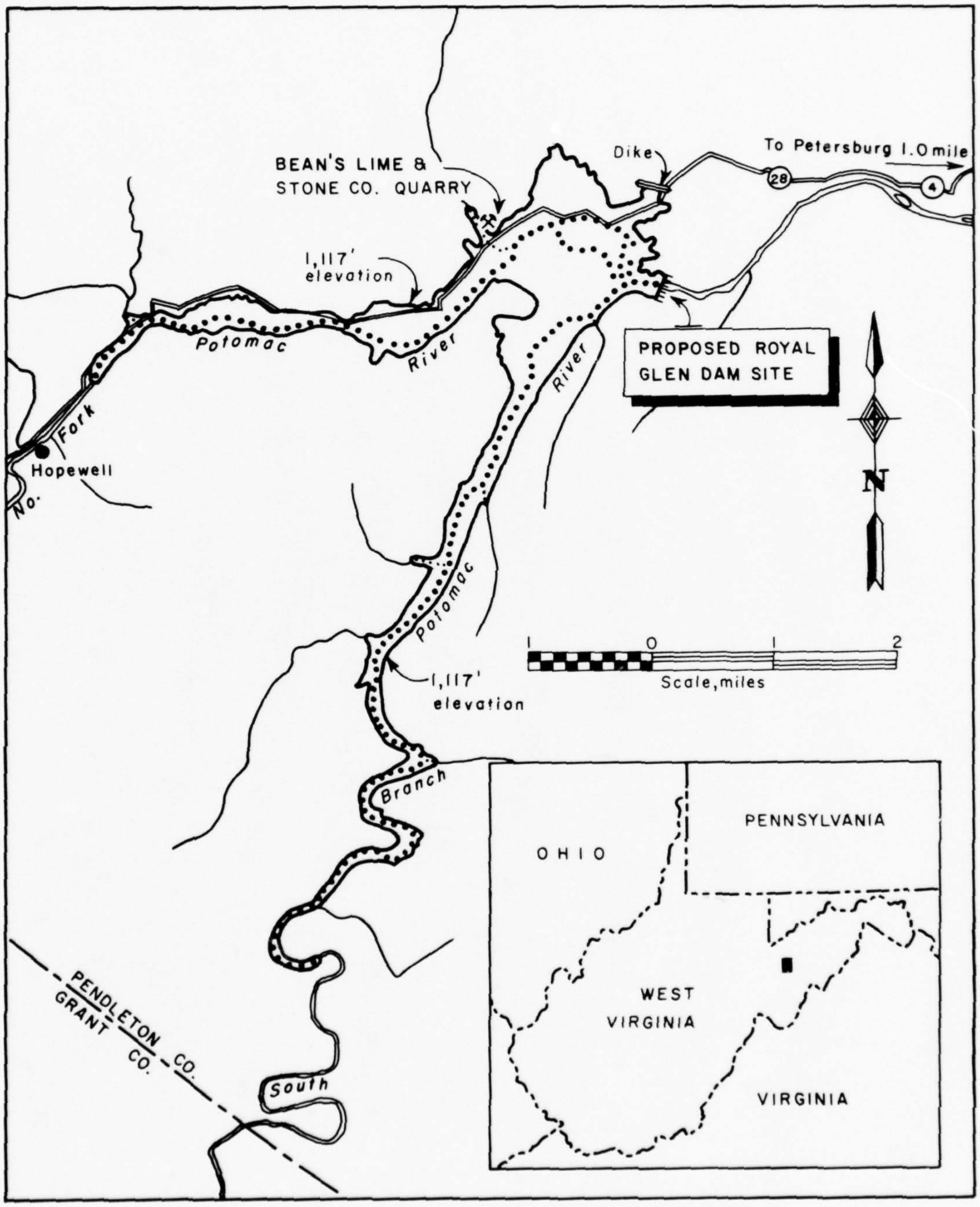

FIGURE 4 - 6. - Location Map of Proposed Royal Glen Reservoir Site, Grant County, W. Va.

MINERAL RESOURCES
IN
THE PROPOSED SAVAGE II RESERVOIR AREA,
POTOMAC RIVER BASIN, MD.

by

Vernal A. Danielson[1/]

ABSTRACT

The proposed Savage II Reservoir site on the Savage River in Garrett County, Md., was investigated for possible mineral resource involvement. A study of available maps and literature, followed by an onsite examination, revealed that no mineral resource conflicts would be encountered in construction of the dam and reservoir.

PROPOSED WATER DEVELOPMENT PROJECT

The Savage II Reservoir proposed by the Corps of Engineers would furnish water for the North Branch and Washington metropolitan areas and provide recreation facilities. A concrete gravity dam and earth dike would impound a 485-acre reservoir at the full conservation pool altitude of 1,684 feet. Maximum flood pool altitude would be 1,704 feet.

LOCATION

The proposed dam would be in Garrett County, Md., on the Savage River, just upstream from the existing Savage I Reservoir, about 10 miles southwest of Frostburg, Md. The narrow reservoir would extend upstream about 3.6 miles (fig. 4 - 7).

TOPOGRAPHY AND GEOLOGY

The proposed site lies on the Allegheny Plateau, a high, deeply dissected plateau formed in gently warped rocks of Upper Devonian and Mississippian age. Flat-lying shales and sandstones and shallow surface soils are predominant in this region.

1/ Mining engineer, Knoxville Office of Mineral Resources, Bureau of Mines, U.S. Department of the Interior, Knoxville, Tenn.

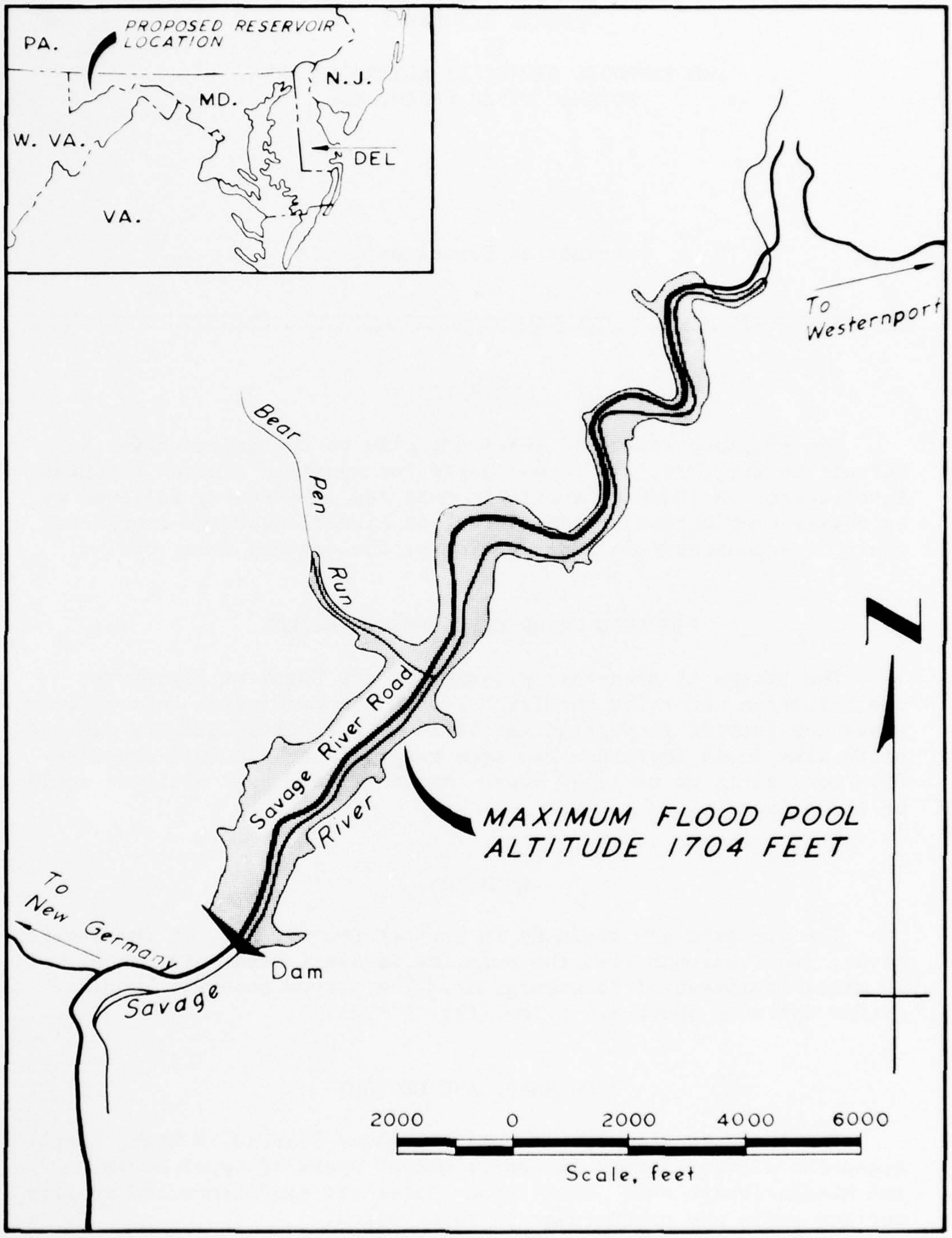

FIGURE 4 - 7. - Location of Proposed Savage II Reservoir.

MINERAL RESOURCES

There are no mining operations in the proposed reservoir site. Some coal is produced in Garrett County, but the coalbeds are found in strata above those occurring in the proposed reservoir site. The sandstone and shale are potential construction materials.

CONCLUSIONS

There would be no mineral resource conflicts in the proposed Savage II Reservoir site. Although there is production of coal from the surrounding area, none is produced from the area of the proposed site. The sandstone and shale might be utilized for construction purposes, but because of the abundance of these materials nearby, but outside the reservoir area, no value should be assigned to their mining rights.

MINERAL RESOURCES
IN
THE PROPOSED CLEAR SHADE CREEK AND UPPER STONEY CREEK
RESERVOIR AREAS, ALLEGHENY RIVER BASIN, PA.

by

Lawrence Y. Marks[1/]

An office review was made of published data and Bureau records. No field examination was made. Two proposed reservoir sites are included in this report because they are near each other and in similar mineral environments.

PROPOSED WATER DEVELOPMENT PROJECTS (2)[2/]

The Clear Shade Creek Dam would be just upstream from the mouth of Clear Shade Creek. It would control a drainage area of 29 square miles, and at a pool elevation of 2,300 feet the reservoir would cover 1,619 acres.

The Upper Stoney Creek Dam would be just upstream from Mostoller, Pa. It would control 74 square miles of drainage area, and the reservoir would cover 485 acres at a pool elevation of 2,200 feet.

Both reservoirs would be entirely in Somerset County, Pa.

MINERAL RESOURCES

Coal, clays, stone, and sand and gravel were produced in 1965 from Somerset County, Pa. (3). Coal-bearing Pennsylvanian strata are at the surface throughout both proposed reservoir areas (1) and minable bituminous coal may occur at either site. Fire clay associated with coalbeds and sandstone may be of commercial importance locally.

Acid drainage derived from coal workings and outcrops might enter either project unless abatement measures have been taken.

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2/ Underlined numbers in parentheses refer to items in the list of references at the end of this report.

CONCLUSIONS

Bituminous coal resources might conflict with either proposed project, and acquisition of coal or provision for coal to be produced in the affected area might add to project costs. Stone and clay resources are expected to conflict less seriously with the projects.

Acid drainage derived from coal workings and outcrops might enter either project unless abatement measures have been taken.

Each site area should be studied in greater detail, including field examinations, to determine quantitatively the extent of mineral involvements.

REFERENCES

1. Pennsylvania Topographic and Geologic Survey. Geologic Map of Pennsylvania. Dept. of Internal Affairs, 1960.

2. U.S. Army Corps of Engineers. Initial Investigations, Pittsburgh Engineer District, for Development of Water Resources in Appalachia. 1966.

3. Yeloushan, C. C. The Mineral Industry of Pennsylvania. BuMines Minerals Yearbook 1965, v. 3, 1967, pp. 679-709.

MINERAL RESOURCES
IN
THE PROPOSED LAUREL HILL CREEK AND UPPER CASSELMAN RIVER RESERVOIR AREAS, MONONGAHELA RIVER BASIN, PA. AND MD.

by

Lawrence Y. Marks[1/]

An office review was made of published data and Bureau records. No field examination was made. Two proposed reservoir sites are included in this report because they are near each other and in similar mineral environments.

PROPOSED WATER DEVELOPMENT PROJECTS (8)[2/]

The Laurel Hill Creek Dam would be just upstream from Ursina, Somerset County, Pa. It would control a drainage area of 115 square miles, and at a pool elevation of 1,600 feet the reservoir would cover 2,234 acres.

The Upper Casselman River Dam would be 1.5 miles upstream from Salisbury, Somerset County, Pa. It would control 72 square miles of drainage area and the reservoir, which would be mostly in Garrett County, Md., would cover 1,823 acres at a pool elevation of 2,180 feet.

MINERAL RESOURCES

Coal, natural gas, stone, sand and gravel, clay, and peat were produced in 1965 from the counties in which the proposed projects are to be constructed (1, 10). Coal-bearing rocks of Pennsylvanian age crop out in both proposed reservoir areas (3, 6). The Upper Freeport, Lower Freeport, Upper Kittanning, and Lower Kittanning coalbeds occur in both proposed project areas (9). In the Maryland portion of the Upper Casselman Site, the Harlem, Lower Bakerstown, Brush Creek, and Middle Kittanning seams also occur. Coal mines and prospects have been operated in the vicinity of the Upper Casselman River site and reserves of coal remain (7). Two limestone quarries

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2/ Underlined numbers in parentheses refer to items in the list of references at the end of this report.

would be flooded by the proposed Upper Casselman River project; other limestone and sandstone quarries and a clay pit have been operated nearby (4-5). There is a natural gasfield about 4 miles west of the proposed Laurel Hill Creek site (2).

Acid drainage derived from coal workings and outcrops might enter either proposed reservoir unless preventive measures have been taken.

CONCLUSIONS

The proposed Laurel Hill Creek reservoir area may contain minable bituminous coal. There also seems to be potential for discovery of natural gas and petroleum. The acquisition of mineral ownership or provision for minerals to be extracted from the area which would be affected by the reservoir might increase the project cost significantly.

The proposed Upper Casselman River reservoir area contains coal reserves. Minable limestone would probably be inundated if this project were completed. Acquiring mineral ownership or providing for minerals to be extracted from the affected area probably would increase project costs significantly.

Acid drainage derived from coal workings and outcrops might enter either proposed reservoir unless preventive measures have been taken.

Mineral resources should be studied in greater detail so that the magnitude of their conflicts with these proposed projects can be estimated. The study should include field examinations of the sites.

REFERENCES

1. Hinkle, M. E. The Mineral Industry of Maryland. BuMines Minerals Yearbook, 1965, v. 3, 1967, pp. 399-406.

2. Lytle, W. S., and L. Heeren. Maps of the Oil and Gas Fields, Natural Gas Pipelines, and Oil Pipelines of Pennsylvania. Pennsylvania Dept. of Internal Affairs, Bur. of Topographic and Geol. Survey, Map 3, 1964.

3. Maryland Geological Survey. Map of Maryland Showing Geological Formations. 1933.

4. O'Neill, B. J., Jr. Atlas of Pennsylvania's Mineral Resources. Part I. Limestones and Dolomites of Pennsylvania. Pennsylvania Dept. of Internal Affairs, Bur. of Topographic and Geol. Survey, Mineral Resource Rept. M50, 1964, 40 pp.

5. Pearre, N. Mineral Deposits of Maryland, Excluding Fuels, Sand, and Gravel. U.S. Geol. Survey Resource Map MR-12, 1961.

6. Pennsylvania Topographic and Geologic Survey. Geologic Map of Pennsylvania. Dept. of Internal Affairs, 1960.

7. Toenges, A. L., L. Williams, L. A. Turnbull, B. C. Parks, H. J. O'Donnell, R. F. Abernethy, W. H. Ode, and K. M. Waage. Castleman Basin, Garrett County, Md. BuMines Bull. 507, 1952, 122 pp.

8. U.S. Army Corps of Engineers. Initial Investigations, Pittsburgh Engineer District, for Development of Water Resources in Appalachia. 1966.

9. Wallace, J. J., J. J. Dowd, T. A. Bowsher, R. F. Abernethy, and D. A. Reynolds. Estimate of Known Recoverable Reserves of Coking Coal in Somerset County, Pa. BuMines Rept. of Inv. 4998, 1953, 20 pp.

10. Yeloushan, C. C. The Mineral Industry of Pennsylvania. BuMines Minerals Yearbook 1965, v. 3, 1967, pp. 679-709.

MINERAL RESOURCES
IN
THE PROPOSED UPPER YOUGHIOGHENY RIVER SITE
MONONGAHELA RIVER BASIN, MD. AND W. VA.

by

Lawrence Y. Marks[1/]

An office review was made of published data and Bureau records. No field examination was made.

PROPOSED WATER DEVELOPMENT PROJECT (5)[2/]

The Upper Youghiogheny River Dam would be just upstream from Crellin, Md.; part of the reservoir would be in Garrett County, Md., and the rest in Preston County, W. Va. The project would control a drainage area of 58 square miles, and the reservoir would cover 5,781 acres at a pool elevation of 2,460 feet.

MINERAL RESOURCES

Coal, stone, natural gas, sand and gravel, and peat were produced in 1965 from the counties in which the Upper Youghiogheny River project is proposed (1, 2).

The Greenbrier Limestone (Mississippian) is exposed the length of the proposed reservoir and limestone has been quarried in the vicinity. Adjacent on the southeast is the Pocono Formation (Mississippian), principally massive coarse sandstone which has been quarried for stone. Pennsylvanian strata containing coalbeds are exposed northwest of the proposed reservoir and some of these rocks might be inundated (3-4, 6-7).

CONCLUSIONS

The proposed Upper Youghiogheny River reservoir probably would inundate limestone and sandstone quarries and reserves of minable

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2/ Underlined numbers in parentheses refer to items in the list of references at the end of this report.

stone. Acquisition of mineral rights would be necessary, but the cost is not expected to be prohibitive because extensive stone reserves seem to be available outside the affected area. Coal might be affected by the project but compensation for it probably would be nominal. Acid-forming materials derived from coal-bearing rocks might enter the stream system, but might be neutralized by drainage from limestone areas.

It is recommended that a field examination and further study be made of the proposed reservoir area to determine the magnitude of conflicts between the project and the mineral resources involved.

REFERENCES

1. Ackerman, M. J. The Mineral Industry of West Virginia. Ch. in BuMines Minerals Yearbook 1965, v. 3, 1967, pp. 871-888.

2. Hinkle, M. E. The Mineral Industry of Maryland. Ch. in BuMines Minerals Yearbook 1965, v. 3, 1967, pp. 399-406.

3. Maryland Geological Survey. Map of Maryland Showing Geological Formations. 1933.

4. Pearre, N. Mineral Deposits of Maryland, Excluding Fuels, Sand, and Gravel. U.S. Geol. Survey Resource Map MR-12, 1961.

5. U.S. Army Corps of Engineers. Initial Investigations, Pittsburgh Engineer District, for Development of Water Resources in Appalachia. 1966.

6. West Virginia Geological and Economic Survey. Geologic Map of West Virginia. 1932.

7. _____. Mineral Resources and Mineral Industries of West Virginia. 1958, map.

SUBREGION C

MINERAL RESOURCES
IN
THE PROPOSED HIPES RESERVOIR AREA
JAMES RIVER BASIN, VA.

by

Robert C. Johnson[1/]

ABSTRACT

The proposed Hipes Reservoir project is located in Botetourt and Craig Counties, Virginia, in the valley of Craig Creek, James River Basin. The general area has a long history of iron ore mining, and some low-grade reserves remain. Mining in the area terminated in 1925. Only one abandoned mine would be within the area of taking and part of it lies below the flood pool elevation of 1,175 feet above sea level. The ore is too low grade to be economically mined at present, but mineral rights will need to be considered in land acquisition. The quality of water in the reservoir is not likely to be adversely affected by mines in the area.

PROPOSED WATER DEVELOPMENT PROJECT

The proposed Hipes damsite in Botetourt County, Va., is located on Craig Creek 14.8 miles above the confluence with James River in the James River Basin. The proposed reservoir would lie in parts of Botetourt and Craig Counties. Streambed elevation at the damsite is 1,007 feet above mean sea level. The maximum conservation pool would be 1,160 feet above mean sea level and would cover 4,500 acres. The maximum flood control pool would be 1,175 feet above mean sea level. Purposes to be served by the dam and reservoir would be flood control, low flow regulation for water quality control, recreation, including fishing and hunting, and possibly water supply. Generation of hydroelectric power would be considered.

LOCATION

Hipes Dam would be located 3/4 mile south of the village of Hipes, Botetourt County, Va. The reservoir at maximum flood elevation would extend up Craig Creek to a point approximately 2-1/2 miles east of the village of Marshalltown, Craig County, Va. Oriskany, Botetourt County, Va., is located in the reservoir area (fig. 4 - 8).

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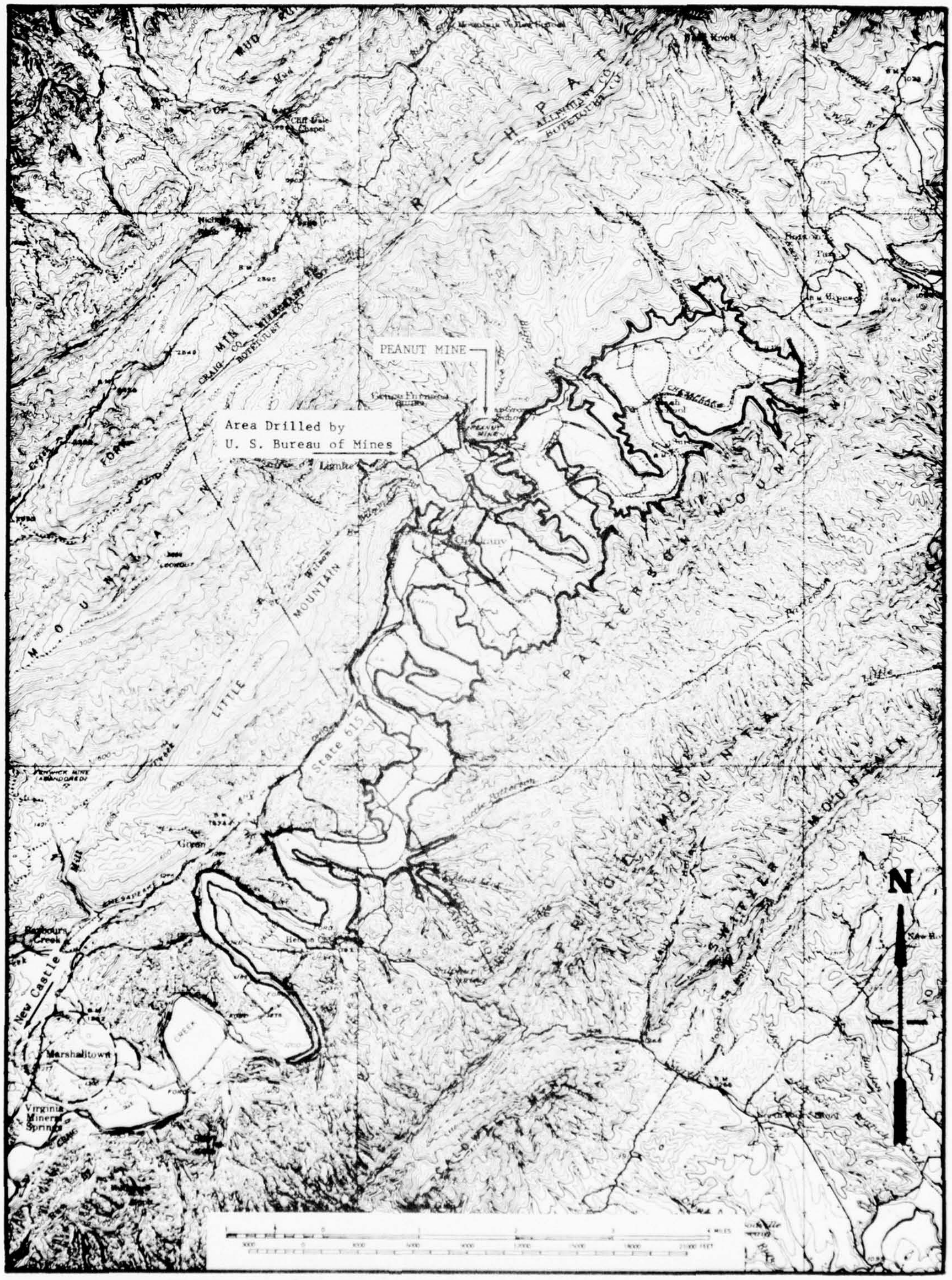

FIGURE 4 - 8. - Location Map, Proposed Hipes Reservoir.

TOPOGRAPHY AND GEOLOGY

The reservoir site is in the Appalachian Valley Ridge and Valley Province (1)[2/]. Local topography consists of anticlinal and monoclinal mountains, ridges, and knobs bordering a broad synclinal shale valley through which Craig Creek meanders. The highest point near the reservoir area is located 3,728 feet above sea level on Rich Patch Mountain. Maximum relief, considering the damsite elevation of 1,007 feet above sea level as the low point, is 2,721 feet. Colluvium-covered spurs in many places extend from the sides of the ridges to the valley floor. The shale valley is at a stage of late youth or early maturity in topographic development.

The valley and lower slopes which would be inundated or taken by the Hipes project are underlain by rocks of Devonian age. These rocks are the Brallier Formation consisting of fine-grained sandstones and shales, the Romney Shale which is predominantly dark colored shale, and an undivided sequence which includes the Ridgeley Sandstone and the Licking Creek Limestone. The Licking Creek Limestone in this area contains supergene replacement deposits of limonite and goethite which are commonly called "Oriskany" iron ore (2).

MINERAL RESOURCES

"Oriskany" iron ore, consisting principally of goethite and limonite, is the only mineral resource in the immediate reservoir area. The "Oriskany" deposits that would be affected lie along the southeastern edge of the area recognized as the Clifton Forge Iron District (2) and on the northern side of Craig Creek. According to Lesure (2), the entire Clifton Forge Iron District produced about 10 million tons of ore during the period 1832 to 1925. The quantity of ore derived from the immediate area of consideration is unknown but probably constituted a very small portion of the total. No active mining has taken place in this area since 1925.

Except for a few small prospect pits, only one mine, the Peanut Mine, on property owned by Alleghany Ore & Iron Co., would be affected by the reservoir. It is located adjacent to Virginia secondary road 615 about one mile northeast of Oriskany in Botetourt County. Surface workings at this mine are evident north of the road. Underground mining was reported (2) and indicated by the presence of caved areas north of the road and an earthfilled mine entrance located below the road at an elevation of about 1,130 feet above sea level. The extent of workings could not be determined, nor could production history be obtained, but local reports indicated that the mine was one of the last to close.

2/ Underlined numbers in parentheses refer to items in the list of references at the end of this report.

As part of the strategic minerals program, the Federal Bureau of Mines conducted a project in 1943 and 1944 to develop the reserves of some of the more important "Oriskany" ore occurrences (3). A total of 163 holes (11,651 feet) were drilled, 236 feet of prospect tunnels were driven, and 1,346 samples were taken. All drilling was farther than 1,000 feet from the proposed flood pool. The nearest holes to the reservoir area and to the Peanut Mine are a group of about 50, located midway between the old mining camp of Lignite and the mine. Twenty-eight of the 50 holes encountered ore containing over 20 percent Fe, 8 holes cut ore containing 15 to 20 percent Fe, and 14 holes found material containing less than 15 percent Fe.

The ore-bearing zone averaged 25 feet in thickness in the area covered by the 50 holes. Specific drill data including chemical analyses are tabularized for each hole in the previously cited Bureau report.

CONCLUSIONS

It is very unlikely that the iron ore which would be affected by the reservoir could be mined profitably in the foreseeable future. The author concurs with Lesure (2) who reported, "The Oriskany iron ores represent a small reserve of rather low-grade ore" and also in reference to reserves proven by drilling by the Bureau of Mines and others, stated, "This ore is too inferior in grade to justify the underground work required to extract it at this time." Because the area has a long history of iron ore mining, and proven low-grade reserves remain, mineral rights should be considered in acquiring land for the reservoir project. However, in view of economic prospects, the value of the iron ore should not add significantly to the cost of land acquisition.

Past mining should have little or no adverse effect on water quality in the reservoir.

REFERENCES

1. Fenneman, N. M. Physiography of Eastern United States. McGraw-Hill Book Co., Inc., New York, 1938, p. 195.

2. Lesure, F. G. *Geology of the Clifton Forge Iron District, Virginia.* Virginia Polytechnic Institute, Engineering Experiment Station Series Number 118, v. L, No. 7, 1957, 130 pp.

3. Morrison, G. A., and W. A. Grosh. Investigation of Oriskany Iron Ore Deposits, Alleghany, Bath, Botetourt, and Craig Counties, Va. BuMines Rept. of Inv. 4668, 1950, 59 pp.

SUBREGION D

Page

Mineral Resources in:

MINERAL RESOURCES IN THE PROPOSED CLINCHFIELD RESERVOIR AREA SANTEE RIVER BASIN, N. C.

by

John W. Sweeney[1/]

ABSTRACT

An onsite examination was made of the proposed Clinchfield Reservoir to determine mineral resource involvement. Access to the quarry and plant of an active granite producer would be lost due to flooding. Compensatory damages would have to be paid.

PROPOSED WATER DEVELOPMENT PROJECT

The water development project proposed by the Corps of Engineers would be on the Broad River, Santee River Basin, in southwestern North Carolina. The purposes of the project include flood control (minor), water supply, water quality control, recreation, including fish and wildlife, and hydroelectric power generation. The maximum normal pool altitude being considered for hydroelectric power is 820 feet with a 5-foot surcharge for flood routing above this elevation. The surface area of this reservoir at an altitude of 820 feet would be about 23,000 acres.

The Bureau of Mines conducted an investigation to determine the mineral resources that would be affected in the proposed reservoir. This investigation was limited to the area encompassed at maximum flood pool altitude plus a 300-foot strip of land measured horizontally and landward of full pool level.

LOCATION

The proposed Clinchfield Reservoir would be in Polk and Rutherford Counties, N. C. The damsite would be about 2,300 feet upstream from the Clinchfield Railroad crossing of Broad River, in Rutherford County. Figure 4 - 9 shows the Clinchfield Reservoir and location of mineral resources that would be affected.

1/ Mining engineer, Knoxville Office of Mineral Resources, Bureau of Mines, U.S. Department of the Interior, Knoxville, Tenn.

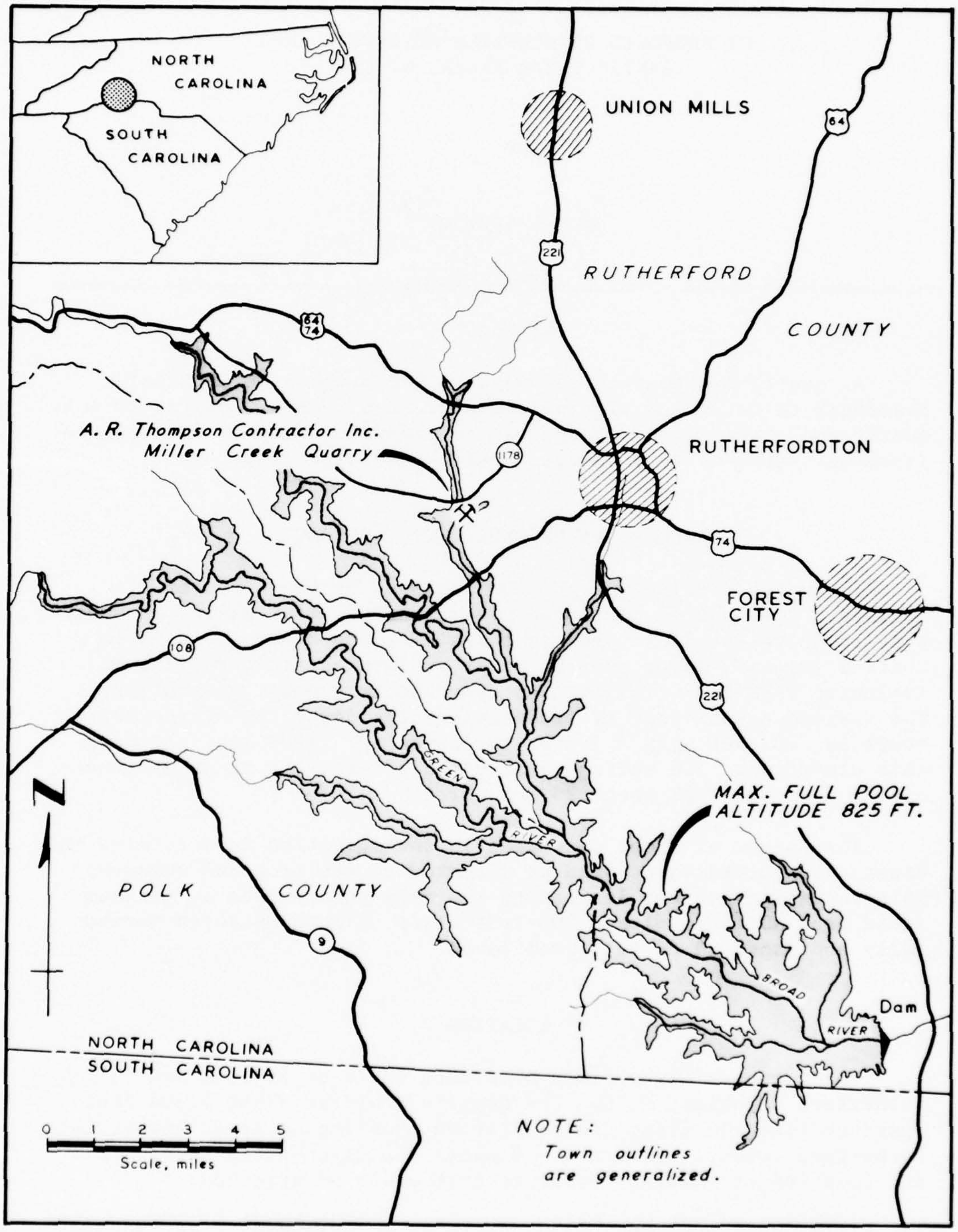

FIGURE 4 - 9. - Location of Proposed Clinchfield Reservoir.

TOPOGRAPHY AND GEOLOGY

The site of the proposed Clinchfield Reservoir is in the Piedmont Plateau province of North Carolina. Topography in general consists of well rounded hills and long rolling ridges with a northeast-southwest trend. This rolling topography is the result of streams acting on rocks of unequal hardness. Where the streams cross ridges, their valleys are narrow and often steep sided.

The bedrock in the proposed reservoir area is chiefly mica-gneiss, mica-schist, and granite, all of probable Precambrian age. In the vicinity of the damsite mica-gneiss and mica-schist are prevalent; upstream near Green River the bedrock is a granite-gneiss complex.

Weathering is very deep in much of the area, and the soils are made up of decomposed gneiss, schist, and granite, with occasional boulders.

MINERAL RESOURCES

Granite is the only mineral commodity that has been mined in the proposed reservoir area.

A. R. Thompson, Contractor, Inc., is presently crushing granite from its Miller Creek Quarry, about three miles west of Rutherfordton, near County Road 1178 on Miller Creek, Rutherford County (fig. 4 - 9). Production from this operation is used mainly for concrete and roads.

At this location, A. R. Thompson, Contractor, Inc., owns 43 acres in fee simple. Reserves of granite-gneiss on this property were not determined. At the quarry site there are three portable crushers and a screening and washing plant. The rock is quarried from a granite-gneiss face approximately 400 feet wide and 100 feet high. Haulage to the consumer is by truck.

CONCLUSIONS

The present operations are at an altitude of 800 feet and the proposed maximum pool would be at 825 feet; therefore, both access and plant site would be inundated. The present access road and the plant site of this operation would be lost due to flooding from the proposed reservoir.

It may be possible to develop new access roads and to quarry stone from this deposit at another site, where the reservoir would not have any effect on these mineral resources. Compensatory damages for relocation of equipment and loss of reserves would be warranted.

MINERAL RESOURCES
IN
THE PROPOSED ROARING RIVER RESERVOIR AREA
YADKIN-PEE DEE RIVER BASIN, N. C.

by

John W. Sweeney[1/]

ABSTRACT

An onsite examination was made of the proposed Roaring River Reservoir in Wilkes County, N. C., to determine mineral resource involvement. No minerals have been produced in the proposed reservoir area and the project would have no adverse effects on mineral resources.

PROPOSED WATER DEVELOPMENT PROJECT

The water development project proposed by the Corps of Engineers would be on the Roaring River, Yadkin-Pee Dee River Basin, in northwestern North Carolina. The purpose of the project is to reduce flood damages, to provide storage for water supply, to provide water quality control, and to provide for recreation.

The project would be in Wilkes County, N. C., where it is proposed to construct an earth dam on the Roaring River about 6,000 feet below State Highway 1990. The maximum flood pool would be at an altitude of 1,115 feet and have a surface area of about 2,600 acres.

The Bureau of Mines conducted an investigation to determine the mineral resources that would be affected by the proposed reservoir. This investigation was limited to the area that would be encompassed at flood pool altitude, plus a 300-foot strip of land measured horizontally and landward of flood pool level.

LOCATION

The proposed reservoir would lie on the Roaring River, in Wilkes County, N. C., with the damsite about 2 miles north of the town of Roaring River (fig. 4 - 10).

1/ Mining engineer, Knoxville Office of Mineral Resources, Bureau of Mines, U.S. Department of the Interior, Knoxville, Tenn.

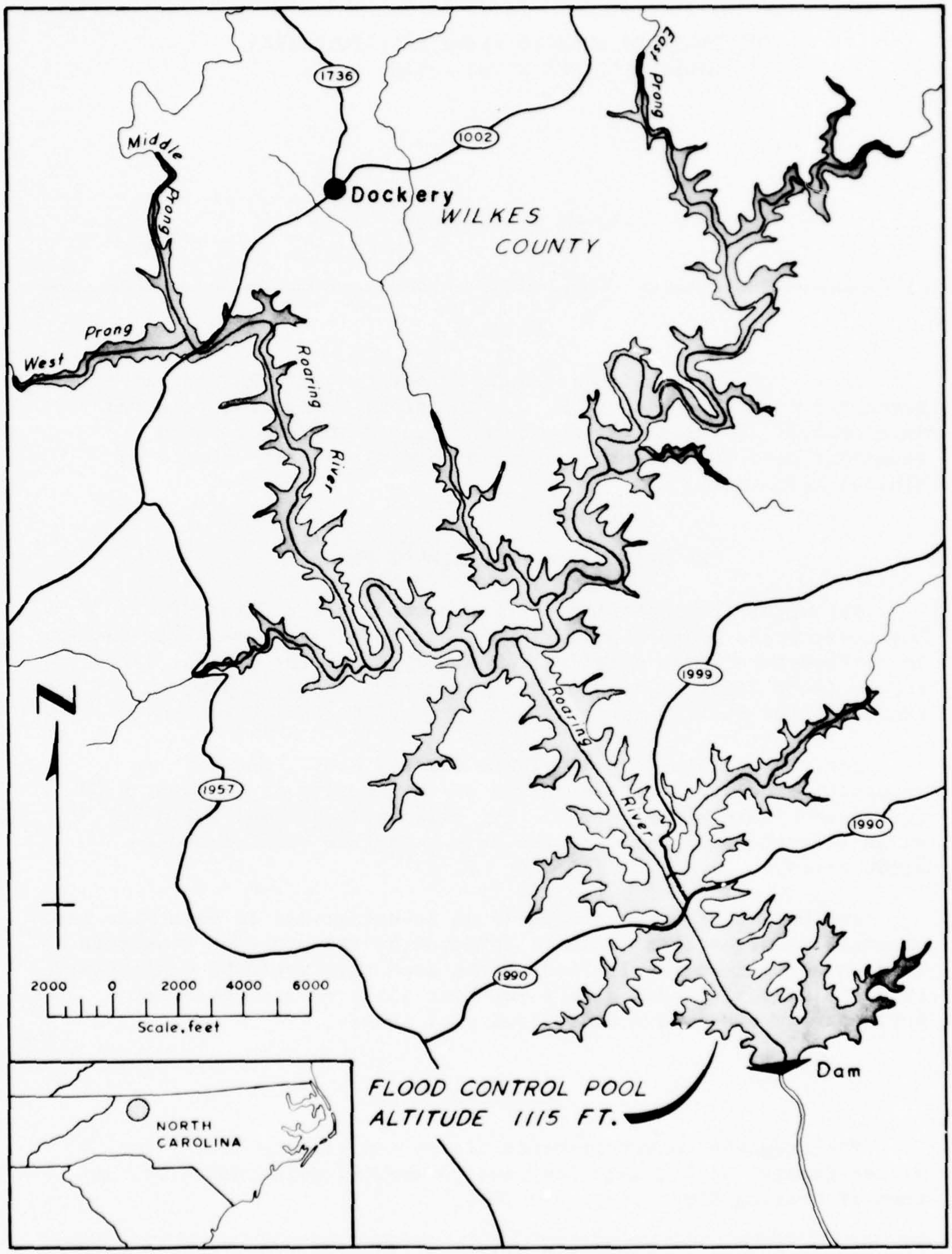

FIGURE 4 - 10. - Location of Proposed Roaring River Reservoir.

TOPOGRAPHY AND GEOLOGY

The proposed Roaring River Reservoir would lie in the Piedmont Plateau province of North Carolina. The general topography of the area is that of well rounded hills and long rolling ridges with a northeast-southwest trend. The stream gradient of the Roaring River is relatively steep, and shoals and rapids are common. In the upper reaches of the reservoir area the river flows on bedrock. The maximum width of the flood plain in the reservoir area is about one-quarter of a mile.

The proposed reservoir area is underlain by three bedrock units. The area of the proposed damsite is underlain by the Mica-Schist unit of probable Precambrian age. The unit in this area consists principally of a thin foliated muscovite-sericite-schist. The unit also includes bands and zones of muscovite-biotite-schist and some areas of mica-gneiss, partly altered to mica-schist. From a point about three miles above the proposed damsite to the town of Dockery, the area is underlain by the Mica-Gneiss unit of probable Precambrian age, consisting of mica-gneiss, mica-schist, and fine granitoid layers in which mica-gneiss predominates. North of Dockery, in the upper reaches of the proposed reservoir, the area is underlain by the Granite unit of probable Paleozoic age, consisting of massive granite intruded into gneiss and schist.

All of the bedrock units are deeply weathered and are covered with a thick residuum of clay which usually contains fragments of the bedrock. Outcrops of bedrock occur at a few places in the riverbed.

MINERAL RESOURCES

There is no record of mineral production in the proposed Roaring River Reservoir area. The mining operation nearest to the proposed reservoir area is the No. 268 crushed granite quarry of Vulcan Materials Co., about 4 miles northeast of North Wilkesboro off State Highway 268. This operation has been inactive since 1962.

CONCLUSIONS

The proposed Roaring River Reservoir would have no effect on known mineral resources.

MINERAL RESOURCES
IN
THE PROPOSED UPPER DONNAHA RESERVOIR AREA
YADKIN-PEE DEE RIVER BASIN, N. C.

by

John W. Sweeney[1/]

ABSTRACT

An onsite examination was made of the proposed Upper Donnaha Reservoir to determine mineral resource involvement. There have been no minerals produced in the proposed reservoir area and there would be no adverse effect on mineral resources.

PROPOSED WATER DEVELOPMENT PROJECT

The water development project proposed by the Corps of Engineers would be on the Yadkin River, Yadkin-Pee Dee River Basin, in northwestern North Carolina. The purpose of the project is to reduce flood damages, provide storage for water supply and water quality control, and provide recreational area.

The project on the Yadkin River would include construction of a dam 152 feet in height and 1,980 feet in length. The flood control pool level of the reservoir would be at an altitude of 862 feet and would have a surface area of 7,600 acres. The total drainage area of the Upper Donnaha Reservoir would be 1,540 square miles.

The Bureau of Mines conducted an investigation to determine the mineral resources that would be affected by the proposed reservoir. This investigation was limited to the area encompassed at flood pool altitude plus a 300-foot strip of land measured horizontally and landward of flood pool level.

LOCATION

The proposed reservoir would form the boundary between Surry and Yadkin Counties, N. C. The proposed damsite would be approximately four miles west of the town of Donnaha on the Yadkin River (fig. 4 - 11).

1/ Mining engineer, Knoxville Office of Mineral Resources, Bureau of Mines, U.S. Department of the Interior, Knoxville, Tenn.

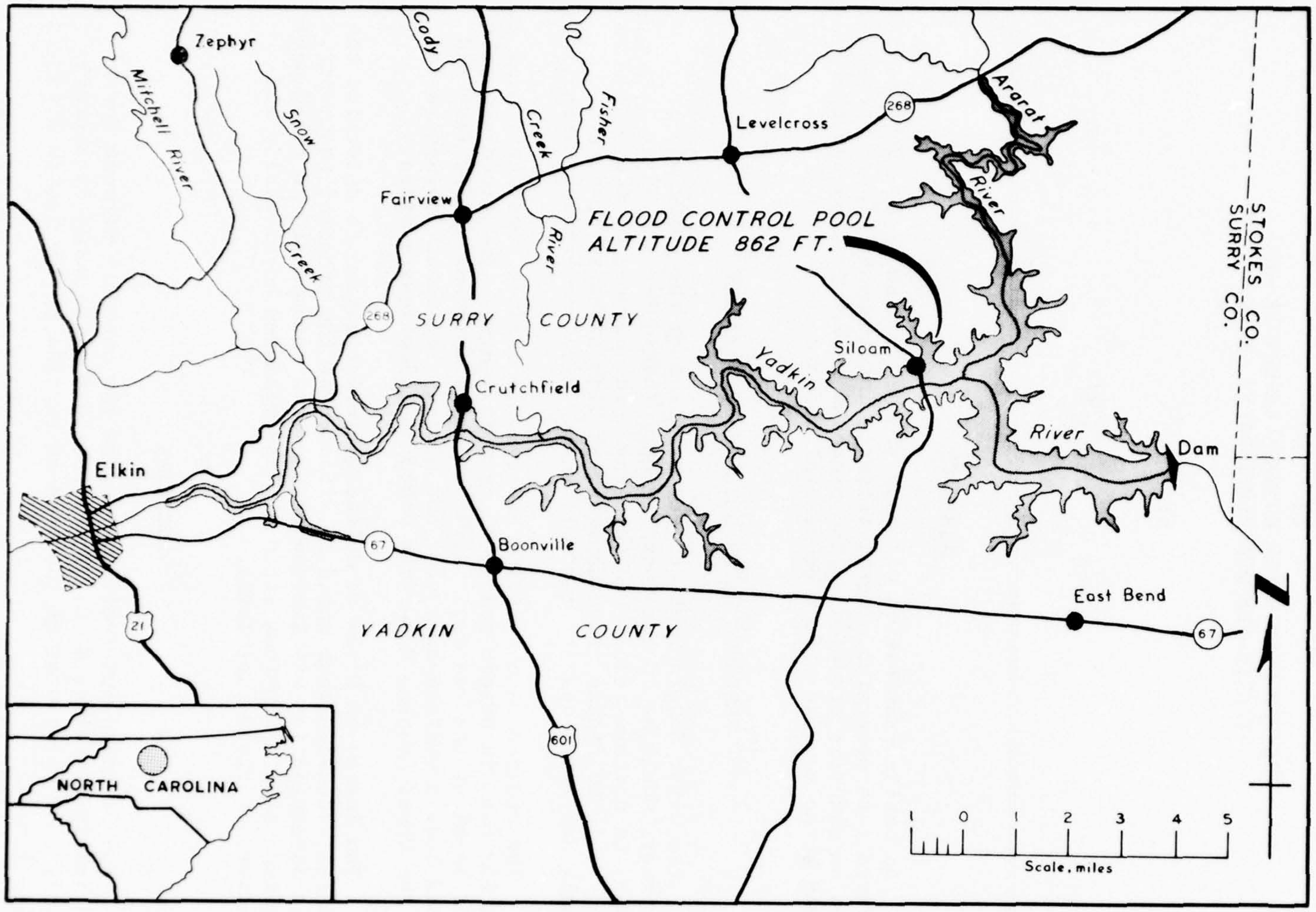

FIGURE 4 - 11. - Location of Proposed Upper Donnaha Reservoir.

TOPOGRAPHY AND GEOLOGY

The proposed Upper Donnaha Reservoir would lie in the Piedmont Plateau province of North Carolina. The general topography of the area is that of well-rounded hills and long rolling ridges. The Yadkin River flows through a broad valley with a well defined flood plain up to one mile wide in places.

The area of the proposed reservoir is underlain by three bedrock units. From the damsite to a point about six miles upstream the area is underlain by the Kings Mountain Group of probable Upper Precambrian or Lower Paleozoic age. The Kings Mountain Group in this area consists of mica-schist, quartz-mica-schist, and quartzite. Near Siloam, Yadkin County, a body of crystalline limestone occurs. From a point about six miles above the proposed damsite to about two miles east of Elkin, the area is underlain by the Mica-Gneiss unit of probable Precambrian age. This unit consists of mica-gneiss, mica-schist and fine granitoid layers in which mica-gneiss predominates. From a point about two miles east of Elkin, upstream to Elkin the area is underlain by the Granite unit of probable Paleozoic age. This unit consists of massive granite which has been intruded into gneiss and schist.

All of the bedrock units are weathered to a depth of from 25 to 65 feet and are covered with a thick mantle of residual clay which usually contains fragments of the bedrock. Fresh bedrock crops out at a few places in the riverbed.

MINERAL RESOURCES

There is no record of any mineral production in the proposed Upper Donnaha Reservoir area. The nearest active mineral operations are Vulcan Materials Co.'s Cycle quarry at Cycle, Yadkin County, and the Elkin quarry about two miles east of Elkin on State Highway 268. Both of these quarries crush granite for roadstone.

CONCLUSIONS

The proposed Upper Donnaha Reservoir would have no effect on known mineral resources.

MINERAL RESOURCES
IN
THE PROPOSED UPPER SALUDA RESERVOIR AREA
SANTEE RIVER BASIN, S. C.

by

John W. Sweeney[1/]

ABSTRACT

An onsite examination was made of the proposed Upper Saluda Reservoir site to determine mineral resource involvement. Because the physical dimensions of the project have not been determined, the area examined is that of a reservoir with an assumed flood pool altitude of 900 feet, upstream from Saluda Lake. Three commercial sand producers are operating at locations that would be inundated. All operators own the land in fee simple. Compensatory damages would probably have to be paid. Sand reserves in the area are not known.

PROPOSED WATER DEVELOPMENT PROJECT

The water development project proposed by the Corps of Engineers would be on the Saluda River, Santee River Basin, in southwestern South Carolina. It is proposed that a dam be constructed above Saluda Lake to control water quality and water supply.

At the time of this writing, the physical dimensions of this project were still under consideration by the Corps of Engineers. However, an assumed flood pool altitude of 900 feet was assigned to this project.

The Bureau of Mines conducted an investigation to determine the mineral resources that would be affected in the proposed reservoir area.

LOCATION

The proposed reservoir would be in Greenville and Pickens Counties, S. C., and the damsite would be above Saluda Lake near State Highway 183. The area covered in this examination is between State Highways 183 and 288, between the 900-foot contour lines on both sides of the Saluda River (fig. 4 - 12).

1/ Mining engineer, Knoxville Office of Mineral Resources, Bureau of Mines, U.S. Department of the Interior, Knoxville, Tenn.

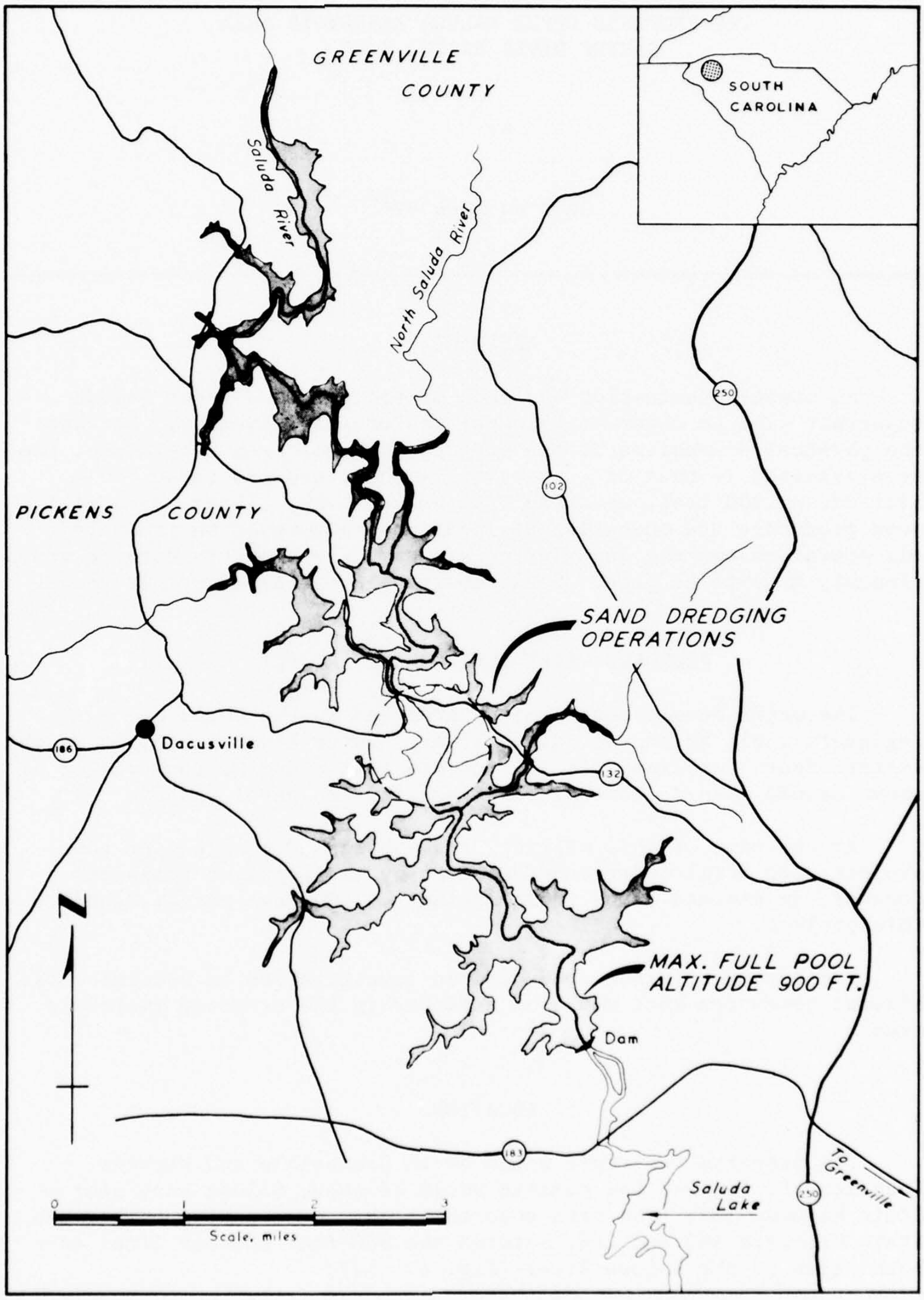

FIGURE 4 - 12. - Location of Proposed Upper Saluda Reservoir.

TOPOGRAPHY AND GEOLOGY

The Upper Saluda River lies in the Piedmont Plateau province, and is incised in a narrow valley ranging from one-half to three-quarters of a mile in width. Topography in the area is rolling with most hills being rounded and low. Soils are residual products of the weathering of granite, gneiss, and schist. Depth of weathering varies considerably throughout the area. The Upper Saluda River flows mainly on bedrock, but has a definite flood plain ranging from one-quarter to three-quarters of a mile in width, containing flood plain alluvium of sand, silt, and loam. Altitudes range from about 860 feet at State Highway 183 to over 1,160 feet at the upper reaches of the river.

The bedrock in the proposed reservoir area is mainly granitic and mafic gneiss with numerous conformable granitic intrusives and lesser bodies of ultramafic rocks all of probably Precambrian age. No evidence of major faulting was observed.

MINERAL RESOURCES

The only known mineral resource in the proposed Upper Saluda Reservoir is sand.

Three companies presently operate sand dredges in the proposed reservoir area. The sand is dredged from the river or adjacent flood plain and pumped to a plant where it is screened. Most of the production is sold in Greenville, S. C., for structural and paving uses. The active companies that would be affected are Zupan Sand Company, Hunts Lake and Sand Company, and Thomas Sand Company, all in the vicinity of State Highway 132 and the Saluda River (fig. 4 - 12).

The proposed reservoir on the Upper Saluda River would flood the above-mentioned sand operations, since they are operating at an altitude of about 850 feet or at the river's elevation.

Land values in the area range from $60 to $125 per acre. Each of the sand operations that would be affected owns its land in fee simple. However, not all land owned by these operators contains commercial sand deposits.

CONCLUSIONS

A considerable quantity of commercial sand would be lost as a result of the proposed dam and reservoir construction on the Upper Saluda River. Reimbursement for loss of sand reserves and processing plants of operating companies should be taken into consideration as well as cost of land acquisition for the reservoir. Other commercial

sand deposits may be available on tributary streams above the maximum pool elevation; however, opening of new deposits may entail a longer transportation route to the consuming market areas.

MINERAL RESOURCES IN THE PROPOSED CURRY CREEK RESERVOIR AREA, ALTAMAHA RIVER BASIN, GA.

by

M. L. Millgate[1/]

ABSTRACT

The proposed Curry Creek project of the U.S. Army Corps of Engineers would develop the North Oconee River and its tributaries within Jackson County in northeast Georgia. This office study of the mineral resources of the area was made by the Bureau of Mines at the request of the Corps of Engineers.

Mineral occurrences of economic interest within the area of influence of the proposed reservoir consist of surface exposures of pegmatite, soapstone, asbestos, and talc. These exposures have not been prospected extensively nor exploited. No mineral production from Jackson County has been recorded in recent years. There probably would be no conflict between the mineral resources of the area and the proposed water resources project.

PROPOSED WATER DEVELOPMENT PROJECT

The Curry Creek water resource project proposed by the U.S. Army Corps of Engineers would develop the North Oconee River and its tributaries, mainly Big Curry Creek and Little Curry Creek, in northeast Georgia. The objectives of the project include flood control, water quality control, recreation, and water supply for nearby communities.

Preliminary plans specify an earthfill dam 1,340 feet long. The reservoir, at an altitude of 710 feet, would provide storage for 185,000 acre-feet of water and cover an area of 5,434 acres.

The investigation by the U.S. Bureau of Mines consisted of an appraisal of reported mineral occurrences in the area. Information was derived from a review of Bureau records and library search.

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LOCATION

The proposed Curry Creek project is about 7 miles southeast of the town of Jefferson in Jackson County, Ga. The proposed damsite is on the North Oconee River about 1,300 feet downstream from the confluence of Big Curry Creek and the North Oconee River (fig. 4 - 13).

TOPOGRAPHY AND GEOLOGY

The project area lies in the Midland Georgia portion of the Piedmont physiographic province (3, pp. 80-82),2/ an area of narrow valleys and low, rounded hills. Total relief is less than 300 feet.

Rocks in the area consist mostly of tightly folded gneiss and schist of Precambrian age cut by dikes, sills, and plugs of granite, pegmatite, and diabase of Precambrian and Paleozoic ages (2, pp. 10, 173). Alluvium of Recent age occurs along the streams.

MINERAL RESOURCES

The known mineral resources of the area subject to inundation by the proposed reservoir are pegmatite dikes and sills and a few occurrences of soapstone with associated asbestos and talc.

Steeply dipping pegmatite dikes as much as 12 feet thick occur throughout the area (1, pp. 128-129). Those reported are composed mostly of quartz and feldspar. Some contain books of mica less than 2 by 3 inches in size. The pegmatites are deeply weathered and much of the feldspar is altered to clay. None have been exploited and little is known of their potential.

Near the confluence of the North Oconee River and Big Curry Creek on the edge of the river marsh are several poorly exposed soapstone boulders. These boulders may not be in place. Near the confluence of Cabin Creek and the North Oconee River, 2 miles upstream from the proposed damsite, is a small soapstone dike. The surface is strewn with fragments of soapstone, fibrous talc, and cross-fiber asbestos over a 1-acre area (2, p. 175). Neither occurrence has been exploited.

There is no recorded mineral production from Jackson County.

CONCLUSIONS

Mineral resources in the reservoir area are of minor importance. The size and quality of known surface exposures of pegmatite,

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2/ Underlined numbers in parentheses refer to items in the list of references at the end of this report.

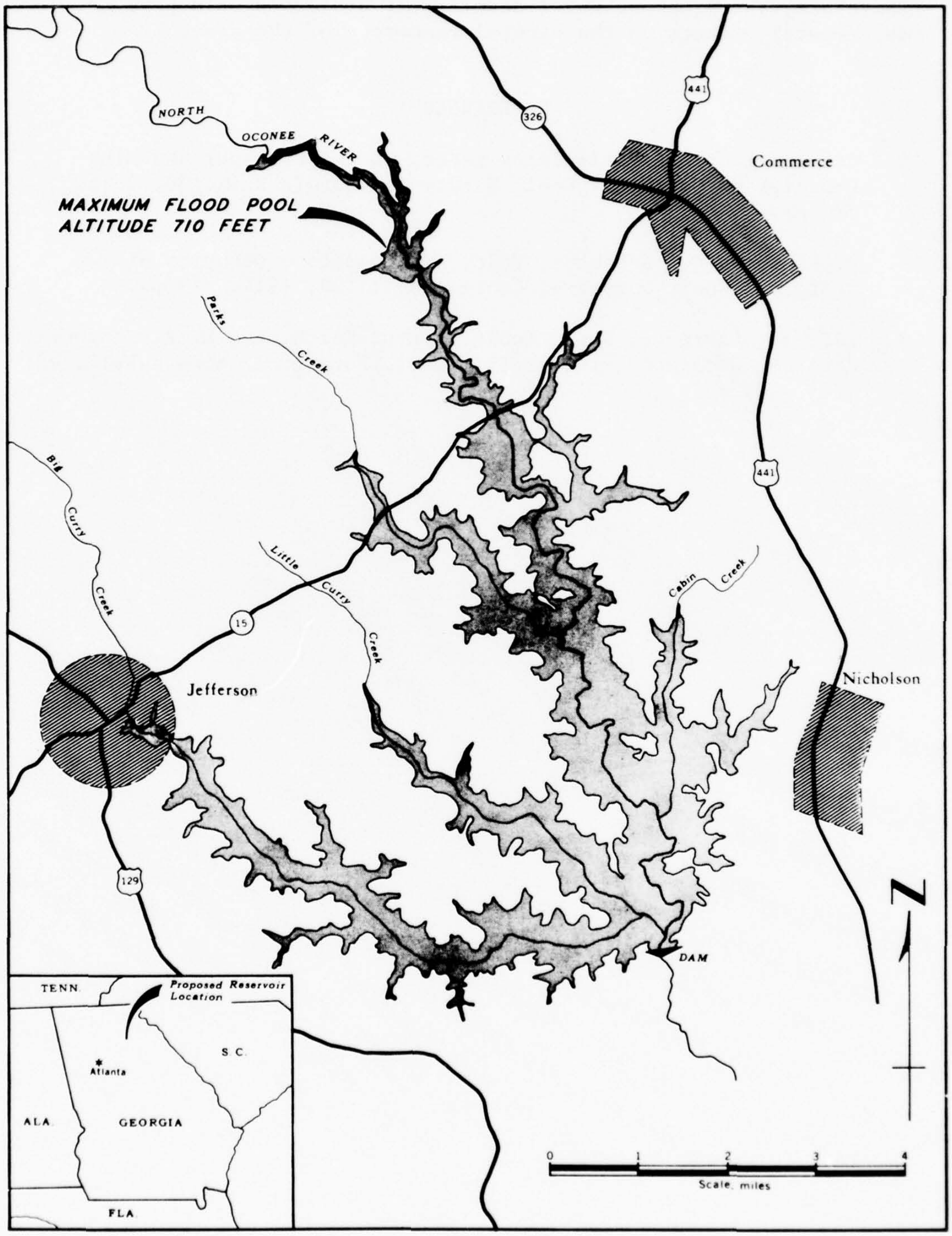

FIGURE 4 - 13. - Location Map of Proposed Curry Creek Reservoir.

asbestos, and talc have been insufficient to warrant development. Therefore, the proposed water development project should have no detrimental effects on the mineral resources of the area.

REFERENCES

1. Galpin, S. L. A Preliminary Report on the Feldspar and Mica Deposits of Georgia. Geol. Survey of Georgia Bull. 30, 1915, 190 pp.

2. Hopkins, O. B. Asbestos, Talc, and Soapstone Deposits of Georgia. Geol. Survey of Georgia Bull. 29, 1914, 319 pp.

3. LaForge, Lawrence, Wythe Cooke, Arthur Keith, and M. R. Campbell. Physical Geography of Georgia. Geol. Survey of Georgia Bull. 42, 1925, 189 pp.

MINERAL RESOURCES
IN
THE PROPOSED FISHER RESERVOIR AREA
YADKIN-PEE DEE RIVER BASIN, N. C.

by

John W. Sweeney[1/]

ABSTRACT

An onsite examination was made by the Bureau of Mines of the proposed Fisher Reservoir to determine mineral resource involvement. No minerals have been produced in the proposed reservoir area, and there would be no adverse effect on mineral resources.

PROPOSED WATER DEVELOPMENT PROJECT

The water development project proposed by the Corps of Engineers would be on the Fisher River, Yadkin-Pee Dee River Basin, in northwestern North Carolina. A dam would be constructed on the river about one-quarter mile below the junction of Cody Creek and Fisher River. The altitude of the normal pool would be 1,010 feet. The maximum flood control pool altitude would be 1,074 feet, with a surface area of about 4,300 acres. The purpose of the project is to reduce flood damage, provide storage for water supply and quality control, and provide recreational areas.

The Bureau of Mines conducted an investigation to determine the mineral resources that would be affected in the proposed reservoir. This investigation was limited to the area encompassed by the reservoir at flood pool elevation plus a 300-foot strip of land measured horizontally surrounding the flood pool level.

LOCATION

The proposed reservoir would lie in Surry County, N. C. The Fisher damsite would be about one-quarter mile below the junction of Cody Creek and Fisher River (fig. 4 - 14).

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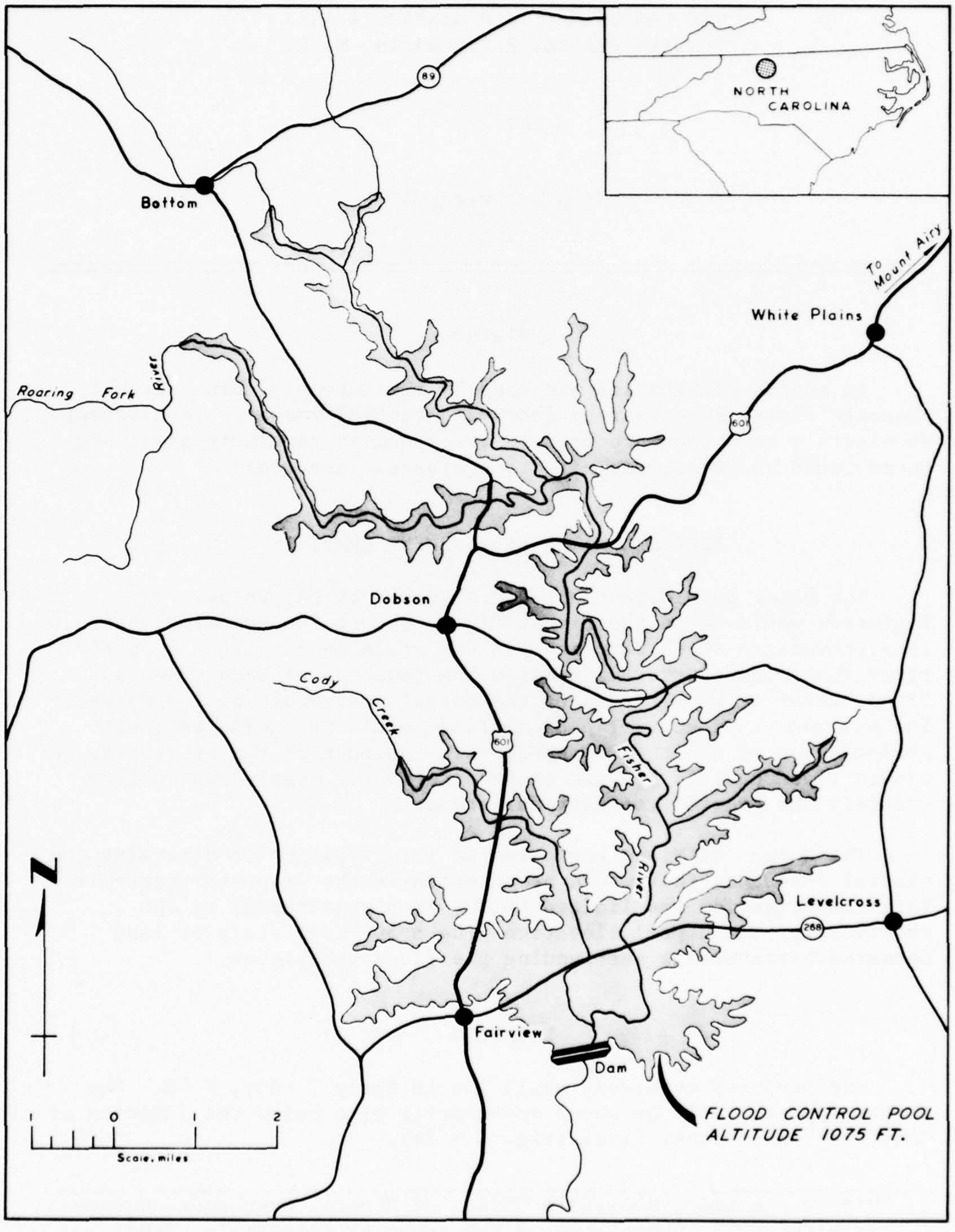

FIGURE 4 - 14. - Location of Proposed Fisher Reservoir.

TOPOGRAPHY AND GEOLOGY

The proposed Fisher Reservoir would lie in the Piedmont Plateau province of North Carolina. The general topography in the area is that of well rounded hills and long rolling ridges. The stream gradient of Fisher River is quite steep, and shoals and rapids are common. The river flows on bedrock at many points in the proposed reservoir area. In one section the river is incised in a narrow valley with a bluff approximately 150 feet high forming one side. The flood plain ranges from one-eighth to one-quarter mile in width.

The proposed reservoir area is underlain by two bedrock units. In the area of the damsite the proposed reservoir is underlain by the Mica-Gneiss unit of probable Precambrian age consisting of mica-gneiss, mica-schist, and fine granitoid layers in which mica-gneiss predominates. In the upper reaches of the proposed reservoir, the area is underlain by the Mica-Schist unit also of probable Precambrian age, consisting chiefly of thin foliated muscovite-sericite-schist; it also includes bands and zones of muscovite-biotite-schist and some areas of mica-gneiss, partly altered to mica-schist.

MINERAL RESOURCES

There is no record of minerals having been produced in the proposed Fisher Reservoir area. Active mining operations nearest to the area are the Elkins, Pilot Mountain, and Mt. Airy quarries, all in Surry County, operated by Vulcan Materials Co., producing crushed granite for concrete and roads.

CONCLUSIONS

The proposed Fisher Reservoir would have no effect on known mineral resources.

MINERAL RESOURCES
IN
THE PROPOSED MITCHELL RESERVOIR AREA
YADKIN-PEE DEE RIVER BASIN, N. C.

by

John W. Sweeney[1/]

ABSTRACT

An onsite examination was made in the area of the proposed Mitchell Reservoir to determine mineral resource involvement. There has been no mineral production in the proposed reservoir area, and there would be no adverse effect on mineral resources as a result of the project.

PROPOSED WATER DEVELOPMENT PROJECT

The proposed water development project of the Corps of Engineers would be on the Mitchell River, Yadkin-Pee Dee River Basin in Surry County, northwestern North Carolina. A dam would be constructed on the Mitchell River about two miles south of Zephyr, N. C. The normal pool altitude would be 1,109 feet. The maximum flood control pool would be 1,169 feet. The reservoir would have a surface area of about 2,750 acres at maximum pool level. The purpose of this project is to provide water quality control and storage for water supply.

The Bureau of Mines conducted an investigation to determine the mineral resources that would be affected in the proposed reservoir. This investigation was limited to the area encompassed at flood pool altitude plus a 300-foot strip of land measured horizontally and landward of flood pool level.

LOCATION

The proposed reservoir would be in Surry County, N. C. The Mitchell damsite would be on the Mitchell River about two miles south of Zephyr, N. C. (fig. 4 - 15).

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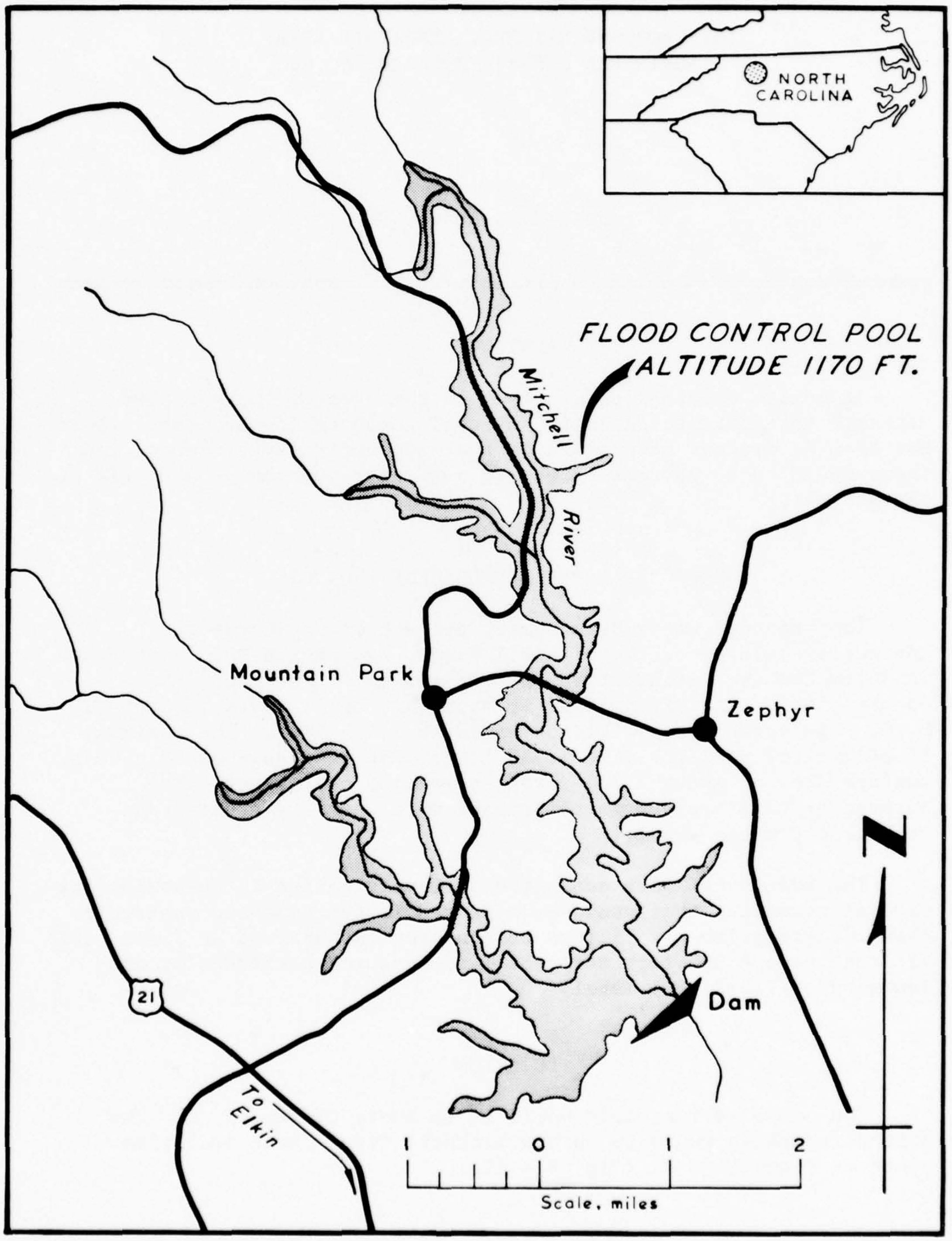

FIGURE 4 - 15. - Location of Proposed Mitchell Reservoir.

TOPOGRAPHY AND GEOLOGY

The proposed Mitchell Reservoir would lie in the Piedmont Plateau province of North Carolina. Topography in general is that of well rounded hills and long rolling ridges. The stream gradient of the Mitchell River is quite steep; it flows in a relatively narrow valley in which very little flood plain has developed.

The area of the proposed Mitchell Reservoir is underlain by two bedrock units. The area at the proposed damsite is underlain by the Mica-Gneiss unit of probable Precambrian age, consisting of mica-gneiss, mica-schist, and fine granitoid layers in which mica-gneiss predominates. In the upper reaches in the vicinity of Zephyr, N. C., the area of the proposed reservoir is underlain by the Mica-Schist unit of Precambrian age, consisting mainly of a thin foliated muscovite-sericite-schist; it also includes bands and zones of muscovite-biotite-schist and some areas of mica-gneiss, partly altered to mica-schist. The bedrock units are deeply weathered and covered with a thick mantle of residual clay which usually contains fragments of bedrock. Bedrock is exposed in a few places in the riverbed.

MINERAL RESOURCES

There is no record of any mineral production in the proposed Mitchell Reservoir area. The nearest mining operation to the proposed reservoir area is the Elkin quarry of Vulcan Materials Co., about 2 miles east of Elkin, N. C., on State Highway 268, producing crushed granite for concrete and roadstone.

CONCLUSIONS

The proposed Mitchell Reservoir would have no effect on known mineral resources.

SUBREGION E

MINERAL RESOURCES
IN
THE PROPOSED ARKADELPHIA RESERVOIR AREA
TOMBIGBEE RIVER BASIN, ALA.

by

F. Vernon Tompkins[1/]

ABSTRACT

The Arkadelphia water development project is an Appalachian Region project under study by the U.S. Army Corps of Engineers. Preliminary plans include a dam on the Mulberry Fork of the Black Warrior River and a reservoir extending upstream into Cullman, Blount, and Walker Counties, Ala. Coal is the only mineral of economic importance near the proposed reservoir; it occurs in one bed which lies 100 feet or more above the altitude of the proposed pool. Most of the coal produced is by strip and auger mining. Extraction of coal available for surface mining is completed, or soon will be completed on many of the hills adjacent to the proposed reservoir. No direct conflict is expected between the water development project and mines or mining.

PROPOSED WATER DEVELOPMENT PROJECT

The Arkadelphia water development project on the Mulberry Fork of the Black Warrior River in north-central Alabama is being studied by the Corps of Engineers to determine the feasibility of building a dam for water storage, power generation, flood control, and recreation. The purpose of the project would be to aid in the economic development of Walker County and vicinity by attracting industry to the area. The project is being studied under the Appalachian Regional Development Act of 1965.

Preliminary plans call for a dam about 2,800 feet long and about 100 feet high to be constructed about 1 mile downstream from the Cullman-Walker-Blount County corner. Maximum altitude of the power pool would be 370 feet and the reservoir would extend about 16 airline miles upstream from the dam.

A mineral investigation by the Bureau of Mines was concerned with the economic minerals in the vicinity of the proposed reservoir. Information was obtained by library research and interviews with personnel

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of coal companies and the State Highway Department of Alabama. Locations of strip mines were noted during a visit to the area.

LOCATION

The Arkadelphia reservoir would be mostly in southeastern Cullman County and southwestern Blount County, Ala. The Mulberry Fork of the Black Warrior River, a stream of the Tombigbee River Basin (fig. 4 - 16), is the boundary between these counties. The damsite would be about 4 miles southwest of the town of Arkadelphia.

TOPOGRAPHY AND GEOLOGY

The topography in the northern part of the drainage basin of Mulberry Fork is undulating farm land and low rolling hills drained by sluggish streams; conversely, in the southern part of the drainage basin higher hills with steeper slopes and local cliffs indicate erosion by more active streams.

The oldest rocks exposed in the drainage basin are limestone, sandstone, and shale of several Ordovician through Mississippian formations. These rocks crop out on the Sequatchie anticline and extend in an elongated concentric pattern, with the oldest formation in the center. Pre-Pennsylvanian rocks are limited to Blount County where the upper Mississippian Formations are unconformably overlain by the Pottsville Formation of Pennsylvanian age. The lower part of the Pottsville Formation, with a maximum thickness of 600 feet, is composed of shale and sandstone, and one or more thin coalbeds. Its exposures are the most extensive in the watershed. The coalbeds are too thin to be economically attractive.

The upper part of the Pottsville Formation is the principal coal-bearing formation of the Region. It consists of alternating beds of shale, sandstone, conglomerate, and coal. In the northern part of the watershed the rocks of this formation have been removed by erosion and in the southern part only the lower portion of the formation remains on the higher hills. The Black Creek coalbed near the base of the upper part of the Pottsville Formation is the only coalbed in the drainage basin with a record of production.

Sand and gravel of Recent age occur along the flood plain in the meander belt of Mulberry Fork and along some of the lower gradient tributaries.

MINERAL RESOURCES

The only mineral of economic importance in the vicinity of the proposed reservoir is coal in the Black Creek coalbed. This is a premium product in the domestic market. Mines or mining would not be in direct conflict with the project because the coalbed is above the altitude of the proposed reservoir but roads to replace those

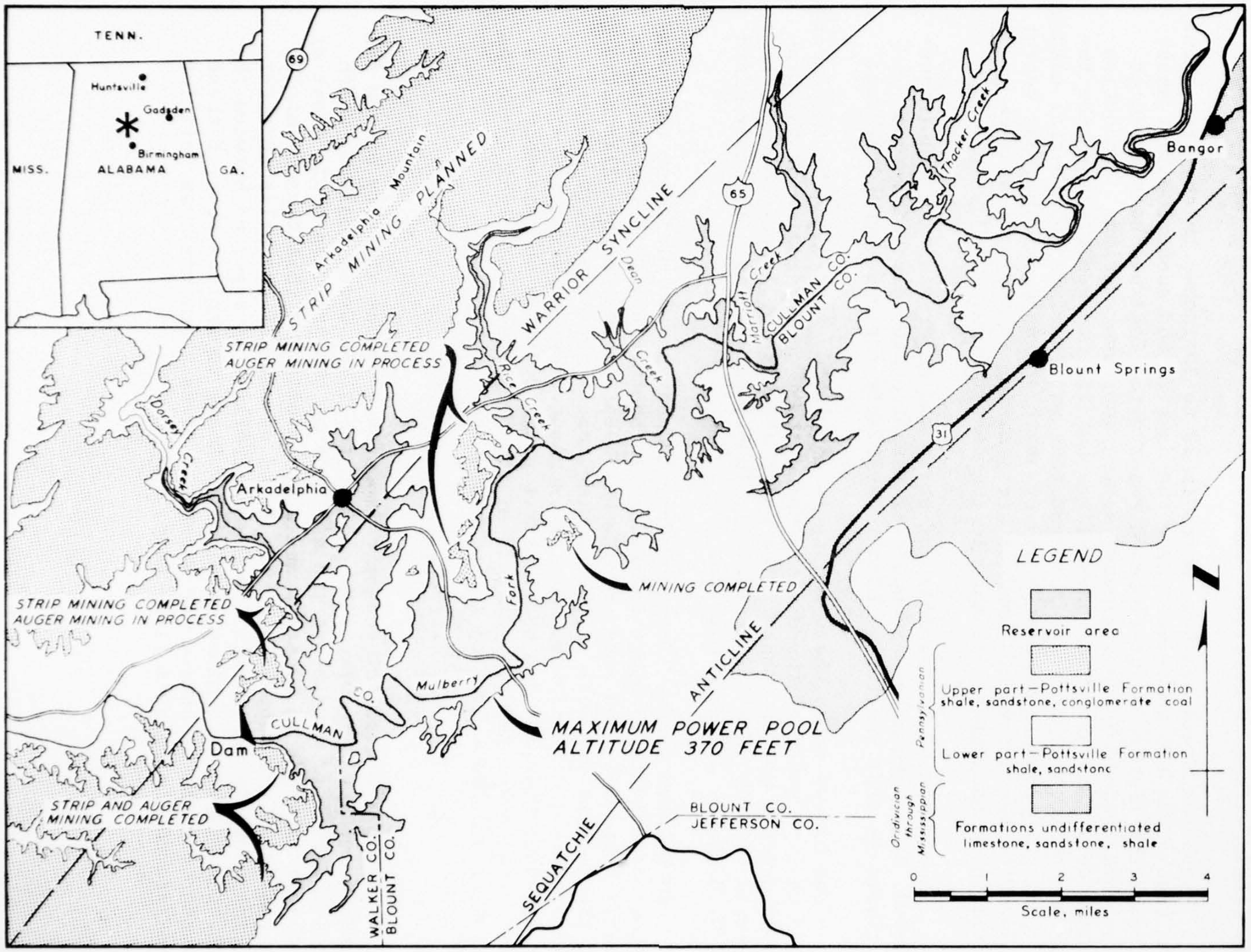

FIGURE 4 - 16. - Location Map of the Proposed Arkadelphia Reservoir.

that would be inundated by the proposed reservoir may be needed for access. Acid mine drainage is not a problem in Alabama and will have but little effect on reservoir water.

The Black Creek coalbed, which is 22 to 30 inches thick, lies about 100 feet above the power pool near the damsite and about 200 feet above it near the center of the proposed reservoir. Coal has been produced from this coalbed by underground, strip, and auger mining. Production from underground mines was never large but it once was greater than the current production of a few thousand tons per year. A substantial tonnage of coal was produced in past years by strip and auger mining, but recent production has dwindled. Contour strip mining in a virgin area on Arkadelphia Mountain is planned in the near future.

The following is a summary of strip and auger mining which is completed, in progress, or planned near the proposed reservoir. Not included is coal remaining which is available for underground mining.

One of two areas where mining is completed, controlled by the Empire Coke Co., is south of the damsite and west of the extension of the proposed pool in Walker County. The other area is in Blount County where a small hilltop in N 1/2 sec. 24, T. 13 S., R. 4 W., was recently mined by D. D. Cupps and Sons Coal Co.

In Cullman County, Drummond Coal Company is now mining at two locations and expects to start operations in another area. Strip mining is nearly completed, and auger mining has been started on the hills north of the damsite and west of the proposed pool, and on a ridge about 2 miles east of Arkadelphia. Mining is planned for an extensive area on Arkadelphia Mountain and should start after delivery and assembly of a 22-cu. yd. power shovel. As this mining progresses, it might reach the steep slopes above arms of the proposed pool.

CONCLUSIONS

The only mineral of economic importance in the vicinity of the proposed Arkadelphia reservoir is coal in the Black Creek coalbed, which lies 100 feet or more above the altitude of the proposed pool. Most of the coal is produced by strip and auger mining and this type of mining is completed, or soon will be completed on many of the hills adjacent to the proposed reservoir. No direct conflict is expected between the proposed project and mines or mining. Roads to replace some of those inundated might be needed for access to areas where coal was left for underground mining at a later date.

MINERAL RESOURCES
IN
THE PROPOSED DALTON RESERVOIR AREA
ALABAMA RIVER BASIN, GA.

by

M. L. Millgate[1/]

ABSTRACT

The proposed Dalton project in Murray and Whitfield Counties, Ga., would develop the water resources of the Conasauga River to benefit the Dalton, Ga., area.

An investigation was made by the Bureau of Mines to determine the nature and extent of the mineral resources and related facilities which would be affected by the proposed reservoir.

At present, there is no direct conflict between the mineral resources of the area and the proposed water development project. One active limestone quarry might be indirectly affected because of damage to, or inundation of haulage and access roads. The present value of the Dalton Rock Products Co. plant and quarry is estimated to be many times greater than the cost of reconstruction and relocation of parts of one existing haulage and access road.

Parts of two pipelines and a metering station owned by the Southern Natural Gas Co. would be inundated by the proposed reservoir. The pipelines would have to be relocated and modified if a dam is constructed at either the prime or the alternate Conasauga site.

Mineral rights in the Dalton area are commonly transferred with the land and have only nominal value.

PROPOSED WATER DEVELOPMENT PROJECT

The Dalton water resources project proposed by the U.S. Army Corps of Engineers would develop the Conasauga River in northwest Georgia. A dam would be constructed at the prime site at Conasauga River mile 24.8 or at an alternate site at river mile 20.9 (Conasauga

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sites). The proposed project would provide water supply, water quality control, flood control, and recreation in the Dalton area. In addition, the project might stimulate growth and accelerate economic expansion in the area.

The storage capacity of the reservoir at the prime site would be 419,000 acre-feet at a maximum reservoir altitude of 700 feet. The reservoir area would total 22,100 acres.

The storage capacity of an alternate site would be 497,900 acre-feet at the same reservoir altitude of 700 feet. The reservoir area would total 25,600 acres.

The Bureau of Mines investigated the mineral resources and related facilities which would be involved in the water development project. Information was obtained from city, county, and industry officials; from library search; and from a brief examination of the reservoir site in July 1967.

LOCATION

The proposed Dalton project (Conasauga sites) is about 6 miles southeast of Dalton, Ga., on the Conasauga River in the Alabama River Basin. The proposed reservoir would inundate reaches of the Conasauga River and its tributaries in portions of Murray and Whitfield Counties (fig. 4 - 17).

TOPOGRAPHY AND GEOLOGY

The topography in the vicinity of the proposed reservoir is characterized by nearly flat-floored valleys as much as 1 mile wide that range from 640 to more than 700 feet in altitude. Gently sloping valley floors are 60 to 100 feet higher away from the streams. Upland ridges and valleys have a total relief of about 500 feet. Higher peaks along the ridges do not exceed 1,200 feet in altitude.

The reservoir area is in the southern section of the Valley and Ridge physiographic province. Folded and faulted sedimentary rocks of Paleozoic age occur in most of the area. Alluvium of Tertiary age occurs in the uplands and Recent alluvium is found mostly along the larger streams. Mineral resources in the proposed reservoir area occur in the Knox Dolomite of Cambrian and Ordovician ages and the underlying Conasauga Formation of Cambrian age. The outcrop pattern of the Knox Dolomite, generalized from published works (1, 5),2/ is shown in figure 4 - 17.

2/ Underlined numbers in parentheses refer to items in the bibliography at the end of this report.

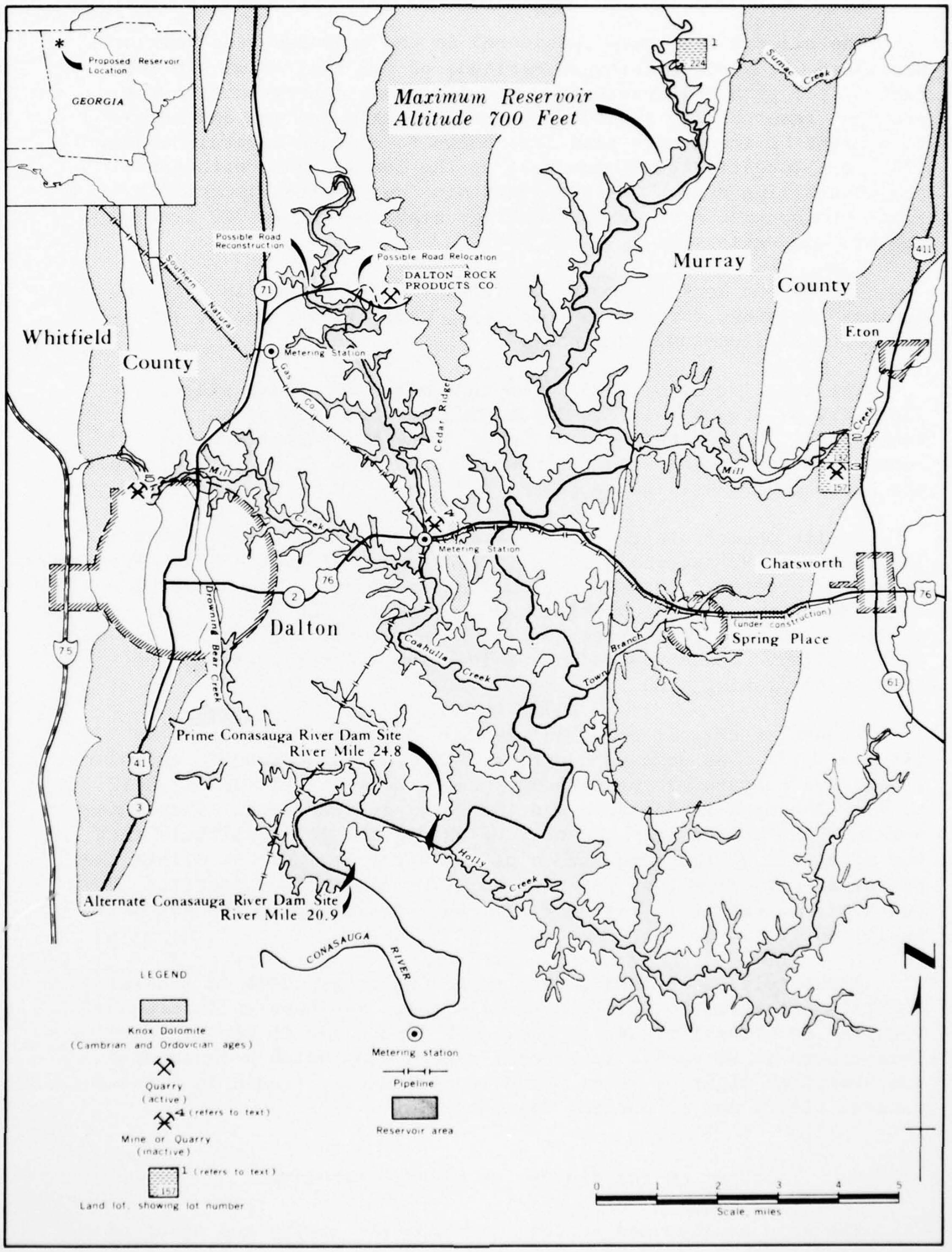

FIGURE 4 - 17. - Location Map of the Proposed Dalton Reservoir Area (Conasauga Sites).

MINERAL RESOURCES

The mineral resources considered in the proposed reservoir area are those which occur below an altitude of 705 feet or within 300 feet of the proposed reservoir. One limestone quarry outside the proposed reservoir is included because the main haulage and access road might be impaired. Land lots known to contain mineral commodities were investigated if any part of the lot would be within the proposed taking area. One abandoned mine near Dalton is briefly described because some of the workings might be within 300 feet of the proposed reservoir.

The Dalton Rock Products Co. (fig. 4 - 17) presently quarries and crushes limestone for use as roadstone, concrete aggregate, and agricultural limestone (agstone).

The inactive O. O. Davis limestone quarry on Cedar Ridge, (locality 4, fig. 4 - 17) is about 250 feet from the proposed reservoir. The southern end of Cedar Ridge is presently being considered for zoning as a residential area, and it is unlikely that the Davis quarry will be reopened.

Barite occurs along Mill Creek near Eton on land lots 132 and 157, district 9, section 3 (localities 2 and 3, fig. 4 - 17). Fragmental barite is scattered through the soil and residual clay. Several carloads of ore were produced in 1907 or shortly thereafter (3, p. 130). Much of the barite remaining in the surface workings is of poor quality. These prospects are inactive and the workings are outside the taking area.

Layers of tripoli occur in the Knox Dolomite at locality 5 (fig. 4 - 17). An unknown quantity of tripoli was produced by underground and surface mining methods, mostly between 1914 and 1918 (2, p. 7). The mine is inactive and the workings are caved. These mine workings are in and near the city of Dalton and it is unlikely that the mine will be reopened. Some of the workings might be within the taking area. Tripoli is reported to occur on lot 224, district 10, section 3 (locality 1, fig. 4 - 17), but apparently it has not been exploited (2, p. 7).

Apparently, most land owners attach no great value to mineral rights. According to County officials there has been no leasing or transfer of mineral rights exclusive of land sales in recent years. Thus, there is no market in mineral rights from which a reasonable cost estimate might be made. Land is customarily traded in fee and mineral rights are of nominal value only.

EFFECT OF THE PROJECT ON MINERAL DEPOSITS

The main haulage and access road from the quarry and plant of the Dalton Rock Products Co. westward to State Route 71 (fig. 4 - 17) is

near the altitude of the proposed reservoir. Portions of this road might be inundated especially across Coahulla Creek, or saturation might cause the road foundation to fail under load. A company representative estimated that 75 percent of their product is transported over this road to markets in and south of Dalton. At present, the marketing area of the company is within a 30-mile radius of the quarry. The use of existing alternate routes above the altitude of the proposed reservoir would increase the haul route about 12 miles, one way. Present markets beyond about 18 miles might be lost. If reasonable access and haulage routes southwestward are denied, the company's operation and use of reserves would be impaired.

The remaining 25 percent of limestone produced is transported southeast, mainly on state maintained roads to the Chatsworth vicinity (fig. 4 - 17). It is assumed that the State would provide comparable roads around or across the proposed reservoir between Dalton and Chatsworth. If this assumption is correct, the future haul distance from the quarry to Chatsworth would not exceed present haul distances to various points within the 30-mile marketing area. Delivery of limestone might be more expensive, but production would not be greatly curtailed due to loss of markets.

The effect of the proposed reservoir, if reasonable access to State Route 71 is cut off, could be failure of the enterprise.

A 12-inch gas pipeline (600 p.s.i.) owned by the Southern Natural Gas Company transports natural gas from Rome, Ga., to Chattanooga, Tenn. Portions of this pipeline and a pipeline metering station (fig. 4 - 17) would be inundated by the proposed reservoir. The company is now constructing a 4-inch pipeline along the south side of U.S. Highway 76 from the 12-inch line to Chatsworth. This 4-inch line was scheduled for completion by October 1, 1967. Parts of this line would also be inundated by the proposed reservoir.

CONCLUSIONS

The Dalton Rock Products Company limestone quarry might be indirectly affected by the proposed reservoir because the haulage and access roads might be inundated or impaired. Preliminary estimates show the present value of the quarry, preparation plant, and limestone reserves to be more than the cost of reconstruction and relocation of parts of one existing haulage and access road. Direct conflict between the water resources project and the Dalton Rock Products Co. quarry could develop in the future if the quarry is extended. Significant quantities of water could seep into the quarry even though available information indicates that rock in and near the quarry does not readily transmit water.

It is doubtful that the inactive quarries, mines, and prospects will be exploited in the future. Some are in residential areas or

areas being considered for residential use; others are submarginal and have been inactive for many years. Reserves of limestone and tripoli are large and widespread and could be developed elsewhere if needed or desired.

Parts of two natural gas pipelines, owned by Southern Natural Gas Co., would be inundated by the proposed reservoir. The lines would be relocated and modified if a dam were constructed at either the prime or the alternate site, adding to the cost of the project.

Mineral rights are customarily traded with the land and are of nominal value only.

BIBLIOGRAPHY

1. Butts, Charles, and Benjamin Gildersleeve. Geology and Mineral Resources of the Paleozoic Area in Northwest Georgia. Geol. Survey of Georgia Bull. 54, 1948, 176 pp.

2. Crickmay, G. W. Tripoli Deposits of Georgia. Georgia Dept. of Forestry and Geol. Devel. Inf. Circ. 9, 1937, 8 pp.

3. Hull, J. P. D. Report on the Barytes Deposits of Georgia. Geol. Survey of Georgia Bull. 30, 1920, 146 pp.

4. Levine, Sidney. Blending with Belt Conveyors. Rock Products, v. 70, No. 6, June 1967, pp. 58-63.

5. Munyan, A. C. Geology and Mineral Resources of the Dalton Quadrangle, Georgia-Tennessee. Geol. Survey of Georgia Bull. 57, 1951, 128 pp.

6. O'Donnell, John P. Pipeline Installation and Equipment Costs. Oil and Gas Jour., v. 65, No. 33, Aug. 14, 1967, pp. 101-116.

7. Robie, E. H., Editor. Economics of the Mineral Industries. AIME, New York, N. Y., 1959, 755 pp.

8. U.S. Bureau of the Census. Census of the Mineral Industries, 1963. General Summary and Industry Statistics: Stone, MIC63(1)-14B., v. 1, August 1966, 68 pp.

MINERAL RESOURCES
IN
THE PROPOSED COOSA RIVER NAVIGATION DEVELOPMENT
COOSA RIVER BASIN, ALA. AND GA.

by

F. Vernon Tompkins[1/]

ABSTRACT

The Alabama-Coosa river system drains an area from northwestern Georgia to southwestern Alabama. A project proposed by the Corps of Engineers would extend the Alabama waterway, currently under development, to include the Coosa River from its confluence with the Alabama River upstream to Rome, Ga.

The Coosa River Basin is in the southern Appalachian mountains of northern Alabama and Georgia. The purpose of a Coosa waterway would be to stimulate the local economy by attracting industry to this Appalachian area. Completion of the Alabama-Coosa waterway would allow the movement of freight by barge at a low cost between Rome, Ga., and Mobile Bay.

In 1965, the mineral industry of the Coosa River Basin produced 13.8 million tons of nonmetals, coal, and metals valued at $74.8 million. Nonmetals accounted for 89 percent of the value of production, coal accounted for nearly 11 percent, and metals accounted for less than 0.5 percent. Included in the mineral yield were barite, bauxite, cement (masonry and portland), clay (fire and miscellaneous clay, and kaolin), bituminous coal, iron ore, lime, mica, sand and gravel, crushed stone (limestone, marble, slate, and sandstone), dimension stone (marble and sandstone), and talc. The long range outlook is for an annual increase in production dependent on continued expansion of the economy in the Southeastern States. Development of a Coosa waterway should accelerate this increase by providing lower freight rates for minerals or mineral products. The low-price nonmetals would receive the greatest benefit by becoming more competitive, particularly in the markets south of the Coosa River Basin.

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PROPOSED WATER DEVELOPMENT PROJECT

The Alabama and Coosa Rivers are a branch of one of the largest river systems in the southeastern United States. They extend from the city of Rome in northwest Georgia to the Mobile River in southwest Alabama. They flow 600 miles with a fall of 556 feet.

Development of the Alabama River into a navigable stream is authorized and work progresses as funds are appropriated. Development of the Coosa River, which drains an area of the southern Appalachian Mountains, is proposed by the Mobile District, Corps of Engineers, under the Appalachian Regional Development Act of 1965. The purpose of the project would be to attract additional industry to this Appalachian area by developing a waterway for moving freight at low cost between Rome, Ga., and Mobile, Ala.

The Coosa River is 286 miles long with a fall of 450 feet. Its head at Rome, Ga., is the confluence of the Etowah and Oostanula Rivers. Its mouth is 14 miles upstream from Montgomery, Ala., where the confluence of the Coosa and Tallapoosa Rivers forms the Alabama River. The project to develop the Coosa River into a navigable stream would require construction of locks in six existing or proposed dams of the Alabama Power Co., realignment of some channels and dredging of others to a 9-foot depth, and relocation of highway and railroad bridges.

At the request of the Office of Appalachian Studies, U.S. Army, Corps of Engineers, Mobile District, an office study of the mineral industry in the Coosa River Basin has been made. The study was concerned with the mineral resources and mineral production of the area commercially tributary to the Coosa waterway. Markets for minerals were considered, including those minerals exported from or imported into the Basin.

LOCATION

The area which is commercially tributary to the Coosa waterway extends from northwest Georgia to central Alabama. Fifteen counties in Alabama and 11 counties in Georgia lie within or have their major part within its boundaries (fig. 4 - 18). Bibb County, Ala., although not in the Coosa River Basin, is included because this Appalachian county is considered to be tributary to the Alabama waterway. These counties cover 13 percent of the combined area of Alabama and Georgia.

TOPOGRAPHY AND GEOLOGY

The drainage basin of the Coosa River extends into four physiographic provinces. The central and largest part of the Basin is in

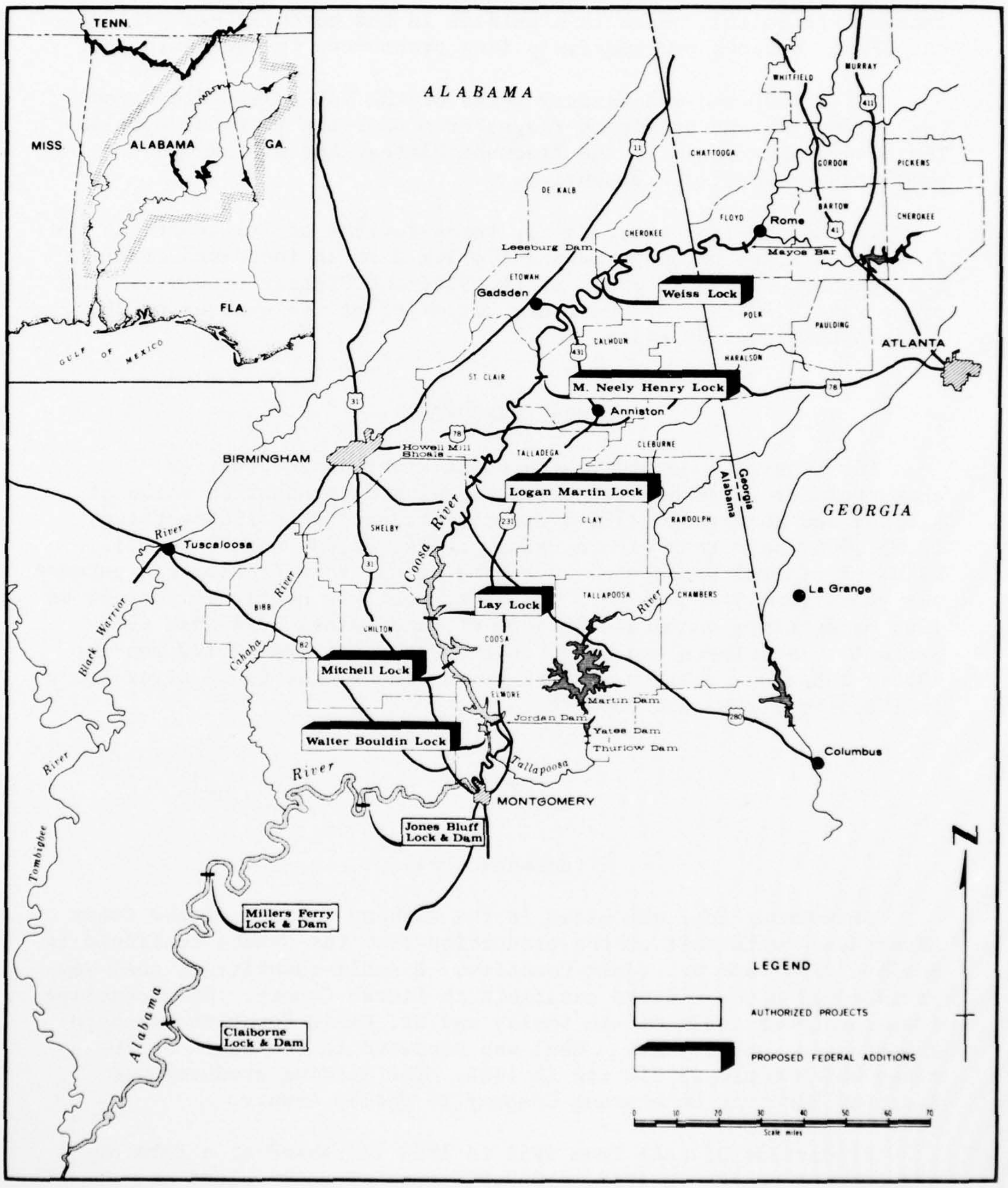

FIGURE 4 - 18. - Location of the Alabama-Coosa River System.

the Valley and Ridge province. Many streams near the southeastern divide originate in the Piedmont Plateau province. Streams flowing off the steep slope of Lookout Mountain drain a small part of the Cumberland Plateau province, and a few tributaries in the northeastern corner of the Basin head in the Blue Ridge Mountains. Topographic relief, which is prominent in the northeastern part of the Basin, becomes progressively less pronounced to the southwest.

The age of the sedimentary rocks of the Valley and Ridge and Cumberland Plateau provinces ranges from Cambrian to Pennsylvanian. The metamorphic rocks of the Piedmont Plateau and Blue Ridge provinces are mostly Precambrian.

The Coosa River meanders for three-fourths of its length in the Valley and Ridge province before flowing with an increased gradient across the metamorphic rocks of the Piedmont Plateau province. The river falls 170 feet in the upper 216 miles of its course and 280 feet in the lower 70 miles.

MINERAL RESOURCES

The mineral industry in the Coosa River Basin counties accounted for 20 percent of the total mineral production value of Alabama and Georgia in 1965. Mineral production in 1965 totaled 13,837,000 short tons with a value of $74,786,000 (table 4 - 2). Value of mineral production increased at the rate of almost 8 percent per year from 1961 to 1965. In value, coal was nearly 11 percent of 1965 production, nonmetals 89 percent, and metals less than 0.5 percent. The mineral industry in the Basin employed 2,120 men in 1965. Table 4 - 3 lists mineral production in the Coosa River Basin in 1965, by States and counties.

Fuels

Bituminous Coal

Bituminous coal was mined in the Alabama portion of the Coosa River Basin with most of the production from the Cahaba coalfield in Shelby, Bibb, and St. Clair Counties. A small quantity of coal was produced from the Plateau coalfield in Etowah County. No production from the Coosa coalfield in Shelby and St. Clair Counties has been reported in recent years. Coal was produced in the Basin at 20 mines which employed 350 men in 1965. The leading producer was Southern Electric Generating Company in Shelby County.

Production of coal from 1961 to 1964 increased at a rate of 31 percent per year. In 1965, 1,047,000 tons of coal valued at $7,896,000 were mined, approximately the same as in 1964; this was nearly 11 percent of the total mineral production in the Basin. Two-thirds of the coal produced was from underground mines and one-third was from strip mines.

TABLE 4 - 2. - Mineral production in the Coosa River Basin[1/]
(Value in thousand current dollars)

Mineral	1961		1962		1963		1964		1965	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Barite......thousand short tons.........	106	$2,046	109	$1,987	117	$2,013	109	$2,023	W	W
Cement:										
Masonry...thousand 280 pound barrels..	W	W	522	1,523	564	1,848	637	1,887	594	$1,775
Portland..thousand 376 pound barrels..	4,650	14,779	4,690	15,183	4,509	13,979	4,639	14,477	4,690	14,421
Clay........thousand short tons.........	682	722	720	890	752	2,060	771	2,303	932	2,901
Coal...............do..................	462	3,470	577	4,858	625	5,202	1,048	7,358	1,047	7,897
Gem stones............................	-----	------	-----	------	(2/)	1	------	------	-----	------
Iron ore....thousand long tons..........	59	298	86	454	56	289	37	208	48	250
Sand and gravel..thousand short tons....	W	W	W	W	850	813	W	W	1,247	1,351
Stone..................do............	7,218	24,776	7,030	24,848	7,824	28,226	10,506	32,634	9,736	35,114
Value of items that cannot be disclosed: Bauxite, lime, manganiferous ore, mica, and values indicated by W.......	XX	9,765	XX	7,662	XX	7,293	XX	8,259	XX	11,077
Total.........................	XX	$55,856	XX	$57,405	XX	$61,724	XX	$69,149	XX	$74,786

XX Not applicable.
W Withheld to avoid disclosing individual company confidential data; included with "Value of items that cannot be disclosed."
1/ Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
2/ Weight not recorded.

TABLE 4 - 3. - Mineral production in Coosa River Basin, by States and counties, 1965[1/]

State and county	Value	Minerals produced in order of value
Alabama:		
Bibb..........	W	Coal, limestone.
Calhoun.......	W	Fire clay, limestone, miscellaneous clay.
Cherokee......	$5,000	Sand and gravel.
Chilton.......	W	Do.
DeKalb........	W	Limestone.
Elmore........	W	Sand and gravel, miscellaneous clay.
Etowah........	W	Coal, limestone, sand and gravel, fire clay.
Randolph......	W	Mica.
St. Clair.....	W	Cement, limestone, fire clay, coal, miscellaneous clay.
Shelby........	27,828,773	Lime, cement, limestone, coal, miscellaneous clay, iron ore.
Talladega.....	W	Marble, limestone, talc.
Georgia:		
Bartow........	4,270,766	Barite, limestone, slate, iron ore, bauxite, iron oxide pigments.
Chattooga.....	W	Marble.
Cherokee......	W	Mica, sand and gravel.
Floyd.........	W	Limestone, miscellaneous clay, kaolin.
Gordon........	17,300	Miscellaneous clay.
Murray........	313,200	Talc.
Pickens.......	W	Marble, sandstone.
Polk..........	W	Cement, slate, miscellaneous clay, iron ore, sandstone.
Whitfield.....	W	Limestone.
Undistributed...	42,350,481	
Total....	74,785,520	

W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."

1/ The following counties are not listed because no production was reported - Alabama: Chambers, Clay, Cleburn, Coosa, Tallapoosa; Georgia: Haralson, Paulding.

A major part of the coal was used locally for generating electricity. Most of the remainder was sold locally to cement and lime plants and in the Birmingham and Gadsden areas where it competes with other southern Appalachian coal as industrial fuel. A small tonnage of coal was sold for residential heating.

Coal reserves[2/] of the Cahaba coalfield in Shelby and Bibb Counties are adequate for many years at the 1965 rate of production. Reserves of minable coal in the Coosa and Plateau fields are small. A long range projection of production must take into consideration the need in the future to mine progressively lower quality coal, thinner coalbeds, or deeper coalbeds.

Nonmetals

Nonmetals production in 1965 accounted for 89 percent of the value of all minerals produced from the Coosa River Basin and over 1 percent of the value of the national nonmetals production.

Barite

Barite was produced in Bartow County, Ga., by four companies which employed 122 men in 1964 and supplied 13 percent of the national barite production. The leading producer was Paga Mining Co.

A major part of the barite production is exported from the Basin to a regional market as an additive for drilling mud. Some barite is marketed nationally as a filler and as barium chemicals which are compounded locally.

Reserves of barite, at the current rate of production, are adequate for many years. Current and future production in the area must compete with barite from Tennessee, South Carolina, and other domestic and foreign sources.

Cement

The greatest concentration of cement producers in the Southeastern States is in southern Appalachia. Three producers are in the Coosa Basin with facilities in Shelby and St. Clair Counties, Ala., and Polk County, Ga. All companies produce both portland and masonry cements. The leading producer of both types of cement is Southern Cement Co., in Shelby County. In 1965, the combined employment of these three companies was 283 men and the value of cement produced was $16,196,000. This represents more than 1 percent of the total national cement production value.

2/ Culbertson, William C. Geology and Coal Resources of the Coal-Bearing Rocks of Alabama. U.S. Geol. Survey Bull. 1182-B, 1964, p. B66.

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DEVELOPMENT OF WATER RESOURCES IN APPALACHIA. VOLUME 24. APPEND--ETC(U)

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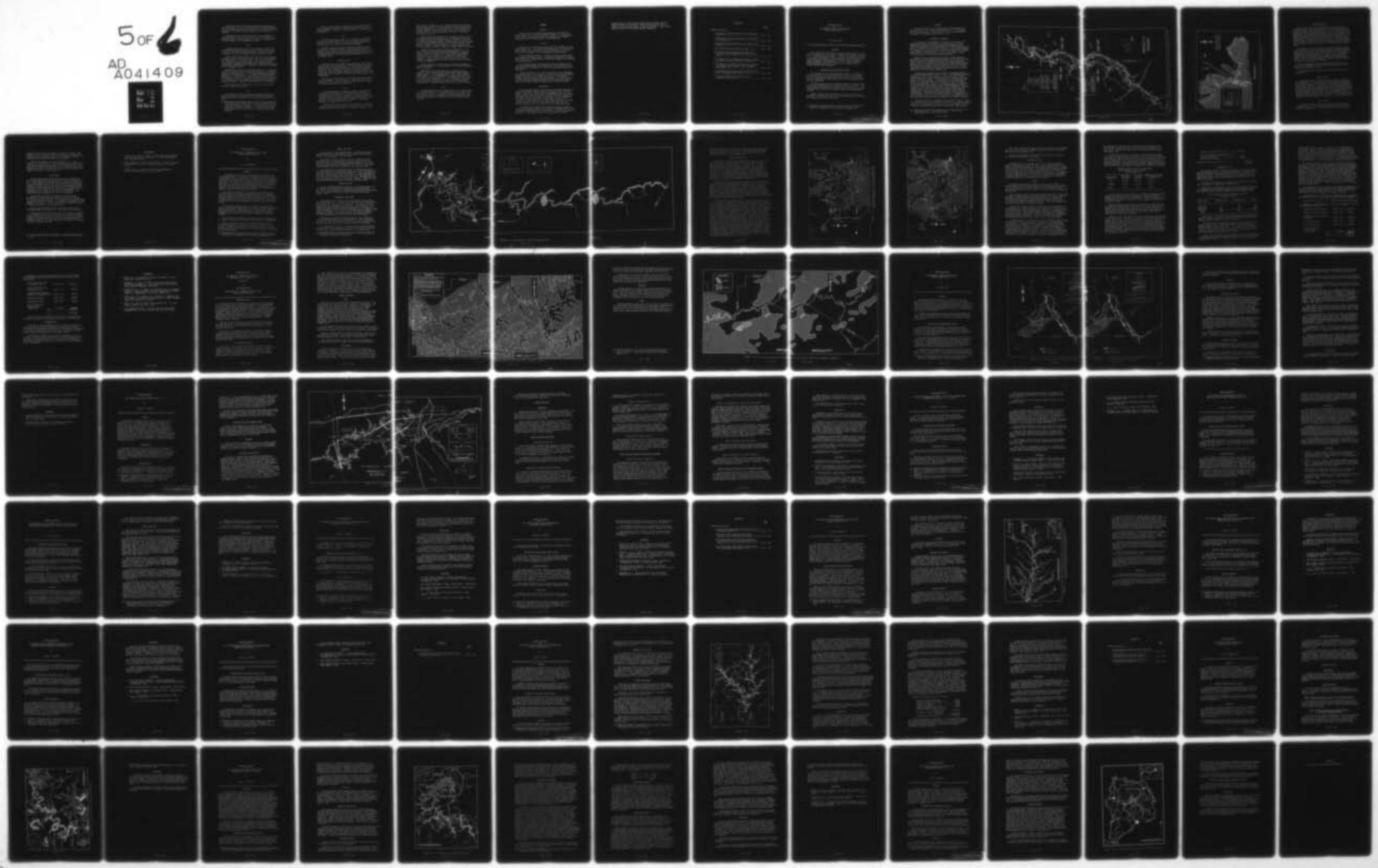

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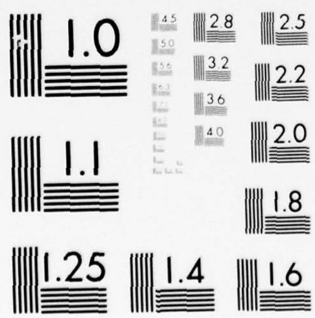


MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

Some cement from the Coosa River Basin was marketed locally, but the major part was sold to regional markets in the Southeastern States in competition with cement produced in other parts of southern Appalachia. The cement was used primarily by the construction industry.

Limestone and clay, the principal raw materials needed for producing cement, occur locally in abundance. The outlook is for a gradual increase in cement production to supply an expanding construction industry in the Southeastern States.

Clays

Combined production of fire clay, miscellaneous clay[3/], and kaolin from the Coosa River Basin was 931,000 tons in 1965, nearly 2 percent of the clays produced nationally. Production of clays increased at the rate of 8 percent per year from 1961 to 1965.

Fire clay was mined in 1965 by five producers at six locations in Calhoun, Shelby, and Etowah Counties, Ala. The leading producer was Donoho Clay Co., in Calhoun County. Refractories (firebrick, etc.) made from fire clay were sold mostly to consumers in the industrialized Birmingham and Gadsden areas. Refractories were sold locally and in regional markets. Reserves of fire clay are adequate for the foreseeable future.

Miscellaneous clay was mined by nine producers at 11 locations in Shelby, St. Clair, Elmore, and Calhoun Counties, Ala., and Floyd, Gordon, and Polk Counties, Ga. The leading producers were Southern Cement Co., and Jenkins Brick Co., in Shelby and Elmore Counties, respectively. Clay produced by cement companies was used locally in the production of cement. Clay produced by other companies was made into building brick or was shipped to adjacent areas for making heavy clay products. Reserves of miscellaneous clay are extensive.

Kaolin was mined in Floyd County, Ga., for use in the manufacture of cement and face brick.

Lime

Five companies produced quicklime or hydrated lime in 1965 in Shelby County, Ala. The leading producer was Southern Cement Co. Production increased at the rate of 5 percent per year from 1961 to 1965.

3/ Miscellaneous clay includes clays and shales of many types used in the manufacture of such products as brick and tile as well as cement and lightweight aggregates. The materials often consist of mixtures of several clay minerals. Products such as pottery, refractories, and fillers also may contain miscellaneous clay and shale.

Lime is a basic industrial chemical; it is also used in mortar and for agricultural purposes. Lime was sold in both local and regional markets. Reserves of limestone suitable for producing lime are plentiful.

Mica

Scrap mica was mined in 1965 by U.S. Gypsum Co., the leading producer, in Randolph County, Ala., and two smaller producers in Cherokee County, Ga. Part of the mica was processed locally and part was sent to St. Louis, Mo., for further grinding.

Ground mica, processed from the Coosa River Basin scrap mica, was used as a coating for roofing, in making plasterboard joint cement, and as a filler for paint, rubber, and other products. The ground mica was marketed nationally in competition with other filler or coating materials. Scrap mica reserves are adequate for the foreseeable future.

Sand and Gravel

Sand and gravel was produced by six companies in 1965, two in Chilton County, Ala., and one each in Elmore, Etowah, and Cherokee Counties, Ala., and Cherokee County, Ga. These companies employed a total of 96 men. Production in 1965 was 1,247,000 tons valued at $1,351,000. This quantity was 12 percent of the total produced in Alabama and Georgia. Leading producers were Alabama Gravel Co., and Wade & Vance Sand & Gravel Co., in Elmore and Chilton Counties, Ala., respectively.

Sand and gravel was marketed in the Basin and adjacent areas as concrete aggregate. In some areas of the upper part of the Basin, there is no sand and gravel acceptable to the construction industry and crushed stone is used as a substitute.

Stone

The combined quantity of limestone, marble, slate, and sandstone mined or quarried in the Coosa River Basin in 1965 was 9,676,000 tons with a value of $35,114,000. This is 1 percent of the quantity and 3 percent of the value of the national stone production. The value of stone produced increased at the rate of 9 percent per year from 1961 to 1965. Producers of crushed and dimension stone employed 888 men in 1965.

Crushed limestone was produced by 20 companies at 22 locations in seven Alabama and three Georgia counties in 1965. The leading producers were Vulcan Materials Co., and Southern Cement Co., both

with quarries in Shelby Co., Ala. Crushed limestone was used for making cement and lime, flux in making iron and steel, agricultural purposes, aggregate for concrete, roadstone, railroad ballast, and in miscellaneous industrial processes. Most of the limestone was marketed locally or in areas adjacent to the Basin. Reserves of limestone are extensive.

Crushed marble was produced by four companies at five locations in Pickens and Chattooga Counties, Ga., and Talladega County, Ala. The leading producer was Georgia Marble Co. with mines or quarries in Pickens and Talladega Counties. Crushed marble is used as terrazzo and for roofing granules and roadstone. Pulverized marble is used mainly as a filler. The marble was sold in local, regional, and national markets. Reserves of marble for crushed stone are extensive.

Crushed slate was produced in Georgia by Rubberoid Co., in Bartow County and by Georgia Lightweight Aggregate Co., in Polk County. Products made from the slate were lightweight aggregate, roofing granules, and slate flour. Lightweight aggregate was marketed in or near the Basin in competition with other mineral materials. Roofing granules and slate flour used as a filler competed in regional markets with other mineral products. Reserves of slate are extensive.

A small quantity of crushed sandstone produced by Marquette Cement Manufacturing Co., in Polk County, Ga., was used in the manufacture of cement.

Dimension stone was produced by three companies at four quarries in 1965. Marble was quarried by Georgia Marble Company in Pickens County, Ga., and Talladega County, Ala., and by Morretti-Harrah Marble Co., in Talladega County. Sandstone was quarried by Hardy Johnson in Pickens County, Ga. The dimension stone was used as building stone, ornamental stone, or for monuments. Dimension marble was marketed nationally in competition with Vermont and foreign marble. Dimension sandstone was sold in or near the Basin.

Talc

Talc was produced in 1965 by Georgia Talc Co., in Murray County, Ga., and American Talc Co., in Talladega County, Ala. Ground talc was used as a filler or a coating for a variety of products. Talc from the Basin competes in regional and national markets with that from other localities and with other types of filler and coating materials.

Metals

Bauxite

A small quantity of chemical-grade bauxite was produced in Bartow County, Ga., in 1965 by American Cyanamid Co. Bauxite from this and other locations in Georgia was shipped to the company's drying plant also in Bartow County, before marketing.

Iron Ore

Brown iron ore was mined in Bartow and Polk Counties, Ga., and Shelby County, Ala. Four companies employed 14 men in 1965 and produced 48,000 tons of ore with a value of $250,000. Iron ore was sold to steel companies in the Birmingham and Gadsden areas.

The New Riverside Ochre Co., produced crude and finished iron oxide pigments in Bartow County. Products were marketed in competition with natural, manufactured, and synthetic pigments from national and foreign sources.

As the higher grade, near-surface deposits are depleted, the remaining reserves become less competitive. The outlook is for no major increase in production, if iron ore from other localities is available.

A high percentage of the iron ore processed in the Birmingham and Gadsden areas is from localities outside of southern Appalachia. Republic Steel Corp., at Gadsden uses iron ore from southern Alabama, southern Georgia, and foreign sources. This ore, as well as steel and steel products exported from the Coosa River Basin, would receive more favorable freight rates if shipped by water.

CONCLUSIONS

The Coosa River Basin in the southern Appalachian Mountains of Alabama and Georgia contains reserves of metals, fuels, and nonmetals. Many of the near-surface, high-grade deposits of iron ore are depleted and local ores generally have become less competitive with those from other sources. The quantity of coal produced has increased in recent years but the long range outlook is for production of lower quality coal, from thinner coalbeds, or mining at greater depth. This coal must compete with that from the Warrior coalfield west of the Basin and other Appalachian areas.

The Coosa River waterway would benefit the mineral industry most by stimulating production of nonmetallic minerals which in 1965 accounted for 89 percent of the total value of mineral production in the Basin. Lower freight rates which would result from the

construction of a Coosa waterway would expand the market area for minerals produced in the Basin. Reduced transportation cost is likely to be of especial benefit by making available a larger market area for low-price, high-volume mineral commodities.

SUBREGION F

MINERAL RESOURCES IN THE PROPOSED PORTAGE RESERVOIR AREA GENESEE RIVER BASIN, N. Y.

by

C. Gordon Leaf[1/]

ABSTRACT

The Portage Dam and Reservoir project proposed by the U.S. Army Corps of Engineers is in Wyoming, Livingston, and Allegany Counties, N. Y., in the Genesee River Basin. A study of the mineral resources of the area by the Bureau of Mines indicated that the project would cause flooding and abandonment of the Ambluco Quarry of American Bluestone Company, East Patterson, N. J. The company produces dressed dimension sandstone ("bluestone") for interior use in schools and municipal buildings.

PROPOSED WATER DEVELOPMENT PROJECT

The proposed Portage Dam and Reservoir project is intended to provide recreation for the Buffalo-Rochester area in conjunction with the adjoining Letchworth State Park. Other project purposes would be flood control, water quality control on the Genesee River, and power generation.

Spillway design flood pool elevation would be 1,195 feet above sea level and conservation pool elevation would be 1,160 feet. The conservation pool would have a surface area of 4,100 acres. At maximum flood pool elevation the reservoir would extend approximately 14 miles.

Bureau of Mines field investigation of this site was done in March 1967. One week was spent in the field examining the site area and interviewing resident land owners.

1/ Geologist, Pittsburgh Office of Mineral Resources, Bureau of Mines, U.S. Department of the Interior, Pittsburgh, Pa.

LOCATION

Portage Dam would be on the Genesee River approximately one-half mile north of the village of Portageville, N. Y., in Wyoming and Livingston Counties. The reservoir would lie within Wyoming, Livingston, and Allegany Counties (fig. 4 - 19).

TOPOGRAPHY AND GEOLOGY

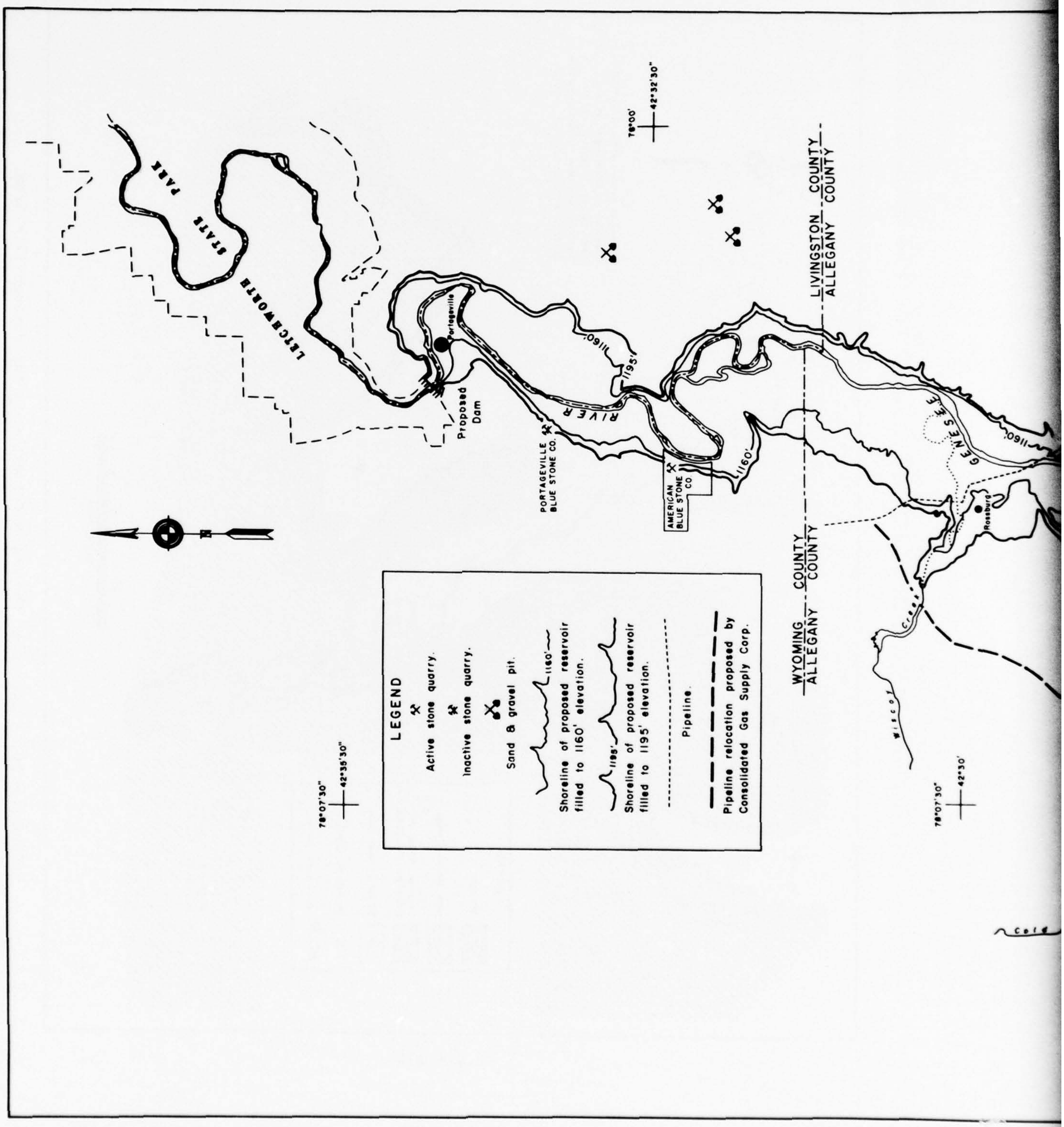
The proposed Portage Reservoir lies within two distinct geographical provinces, the highlands of Allegany County and the transitional escarpment zone in Wyoming and Livingston Counties (1).[2/] At Portageville the Genesee River flows north over the escarpment and drops in a series of three cataracts. The proposed damsite is upstream from these cataracts. South of Portageville the Genesee River gradient is moderate and the river winds through a broad valley with gently to moderately sloping hillsides.

Bedrock in the area consists of a series of Upper Devonian sandstones and shales dipping south-southwest 40 to 60 feet per mile. Most of the rock is covered with glacial clay, sand, and gravel. Glacial deposits are relatively thin (10 to 50 feet thick) on the uplands, but in the valleys of the Genesee River and its tributaries the deposits are commonly from 100 to 300 feet thick (3). In the Genesee River gorge between Portageville and Mount Morris, however, bedrock is at or close to the land surface.

Of particular interest to this report is the Nunda Formation of the Upper Devonian System (fig. 4 - 20). The formation has a total thickness of 215 feet and consists of shales and thin- to thick-bedded sandstones. Some of the sandstones are calcareous and hard, while others are schistose or coarsely shaly. The sandstone beds weather to a yellowish-gray or olive-gray color but on a fresh surface are blue-gray. The stone is popularly known as "bluestone." It is typically a fine-grained, evenly bedded sandstone showing a tendency to split along lines parallel to its bedding (1). The more compact layers of this "bluestone" are presently being quarried along the west side of the Genesee River about 2 miles south of Portageville. "Bluestone" has reportedly been quarried from the Nunda Formation at Rock Glen (9 miles northwest of Portageville) and also 1-1/2 miles south of Nunda (5 miles east of Portageville) (1). The latter two areas would not be flooded by the proposed reservoir.

The Nunda Formation is extensive in the district (fig. 4 - 20), but in most places it is covered by glacial till and outwash sediments. Outcrops of the sandstone are limited to the river gorges, particularly at Portageville and downstream in Letchworth State Park (1).

2/ Underlined numbers in parentheses refer to items in the bibliography at the end of this report.



LEGEND
Active stone quarry.
Inactive stone quarry.
Sand & gravel pit.
Shoreline of proposed reservoir filled to 1160' elevation.
Shoreline of proposed reservoir filled to 1195' elevation.
Pipeline.
Pipeline relocation proposed by Consolidated Gas Supply Corp.
LETCHWORTH STATE PARK
Portageville
Proposed Dam
GENESEE RIVER
PORTAGEVILLE BLUE STONE CO.
AMERICAN BLUE STONE CO
LIVINGSTON COUNTY
ALLEGANY COUNTY
WYOMING COUNTY
ALLEGANY COUNTY
Rossburg
Wiscoy Creek
1160'
1195'
78°00'
42°32'30"
78°07'30"
42°35'30"
78°07'30"
42°30'

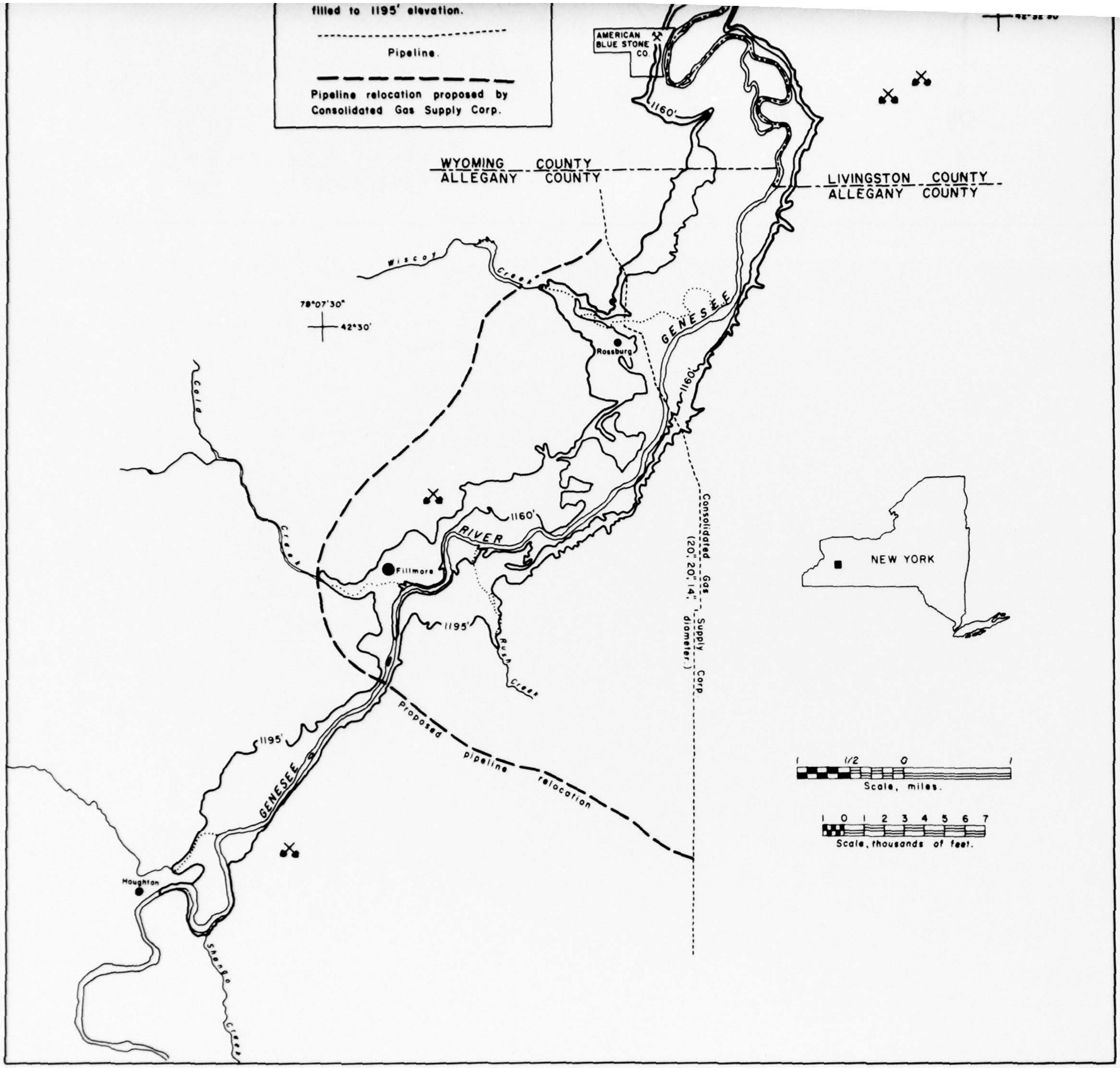


FIGURE 4 - 19. - Proposed Portage Dam and Reservoir with Mining Operations and Pipeline Locations.

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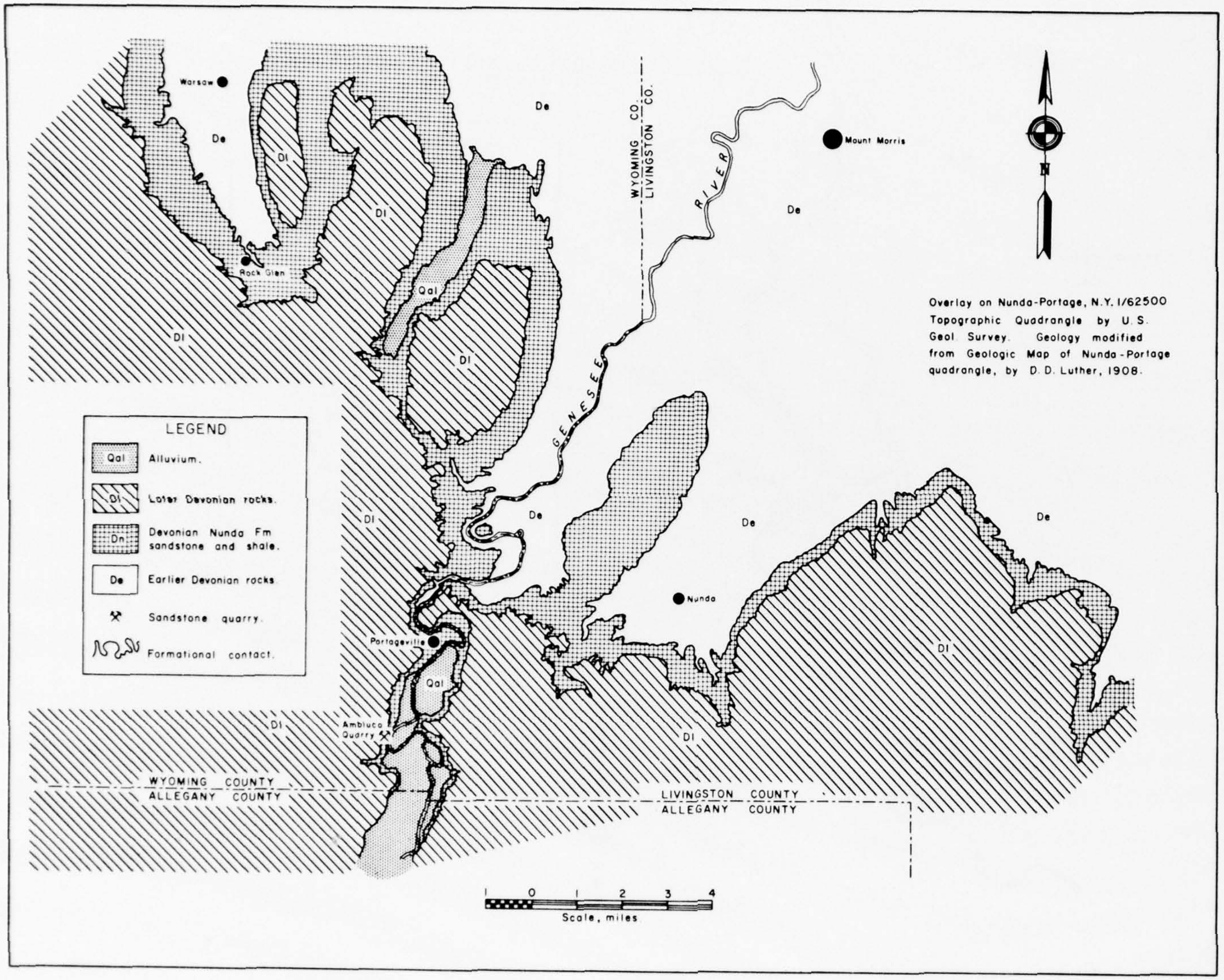

FIGURE 4 - 20. - Extent of the Nunda Formation in the Portageville Area.

MINERAL RESOURCES

Known mineral resources in the proposed project area are dimension sandstone and sand and gravel. No sand and gravel operations were found in the proposed reservoir area, but five pits were examined near the proposed maximum pool limits. All appeared to be intermittent operations with no crushing or washing facilities. The largest pit observed, about 600 feet long and 250 feet wide, is three-quarters of a mile north of Fillmore, N. Y. Sand and gravel from this pit is used by the village of Fillmore for fill. Present access to the pit would be cut off by the reservoir at maximum flood pool elevation but a new access road could be provided at nominal cost.

Two dimension stone quarries are located within the proposed reservoir area. The former Portageville Bluestone Company property located on the west side of the Genesee River, 1-1/2 miles south of Portageville, has been inactive for 30 to 40 years. The quarry is now covered with slide material and vegetation. One-half mile farther south is the Ambluco Quarry owned by American Bluestone Company. This is an active operation producing dimension sandstone for interior flooring and stair treads.

Both of these quarries would be inundated if a dam is constructed at Portageville. All economically minable stone at the Ambluco Quarry would be flooded.

Sand and gravel and sandstone would be available for use in construction.

Ambluco Quarry

The Ambluco Quarry is owned by American Bluestone Company of East Patterson, N. J. The company produces dressed architectural "bluestone" for interior use in schools and municipal buildings as stair treads, platforms, and flooring. A limited quantity of stone is also sold locally for flagging and riprap. The proposed dam at Portageville would cause flooding of this quarry and finishing plant and the operating company reports that it would abandon stone quarrying operations in the area. American Bluestone Company owns surface and mineral rights on 198-1/4 acres. The quarry has been in operation since before 1870 but production data are not available.

Gas Pipelines

Three gas pipelines owned by Consolidated Gas Supply Corp., Clarksburg, W. Va., cross the proposed reservoir area near the village of Rossburg, N. Y. The lines (20, 20, and 14 inches in

diameter) would be in the reservoir for about 1-3/4 miles. The company also has a measuring station at Rossburg. The pipelines would have to be relocated or modified for underwater service. The measuring station would also have to be relocated.

The pipelines supply gas to the Rochester, N. Y., area; therefore, it is difficult to take the lines out of service without seriously disrupting the gas supply for the Rochester area. Any relocation of these facilities could only be done between the first of May and the first of October and only one line at a time can be taken out of service to make tie-ins.[3/]

CONCLUSIONS

The proposed Portage Dam and Reservoir would inundate one active mining operation, the Ambluco Quarry south of Portageville, N. Y. The company could possibly move to another location out of the proposed reservoir area, but this would involve an exploration program to determine quality and extent of the high-quality sandstone beds of the Nunda Formation, acquisition of quarrying rights to suitable stone, relocation of the plant and equipment, and development work to prepare a new quarry for production. The company should be compensated for loss of its property.

One inactive dimension stone quarry, formerly owned by Portageville Bluestone Company, would also be lost by flooding. This quarry, one-half mile north of the Ambluco Quarry, has not been in operation for 30 to 40 years. No buildings or equipment of value remain on the property. Cost of acquiring this property should not be higher than that of the surrounding land.

Natural gas pipelines crossing the reservoir area and the measuring station at Rossburg, N. Y., would have to be relocated.

Sand and gravel reserves would be lost as a result of flooding by the proposed reservoir but no operating pits would be flooded. Access to one sand and gravel pit would be cut off by the reservoir at maximum flood pool elevation but a new access road could be provided at minimum cost. Sand and gravel is available in abundance outside the proposed reservoir.

3/ Guy H. Bradley, Chief Civil Engineer, Consolidated Gas Supply Corp.

BIBLIOGRAPHY

1. Clarke, J. M., and D. D. Luther. Geologic Map and Descriptions of the Portage and Nunda Quadrangles. New York State Museum Bull. 118, 1908, 88 pp.

2. Parks, Roland D. Examination and Valuation of Mineral Property. Addison-Wesley Press Inc., Cambridge, Mass., 3rd ed., 1949, p. 367.

3. Woodruff, John G. Geology of the Wellsville Quadrangle. New York State Museum Bull. 326, 1942, 135 pp.

MINERAL RESOURCES
IN
THE PROPOSED ST. PETERSBURG RESERVOIR AREA
CLARION RIVER BASIN, PA.

by

E. L. Hemingway[1/]

ABSTRACT

A multipurpose reservoir and recreation area proposed by the Pittsburgh District, U.S. Army Corps of Engineers would be on the Clarion River, Clarion County, Pa. The Bureau of Mines conducted an investigation of the mineral resources in the area at the request of the Corps. For simplicity, the reservoir and recreation areas are referred to in this report as individual components. Coal, natural gas, and petroleum would be affected adversely by the proposed project. Clay, sand and gravel, and limestone are produced in the region but are not within the areas involved.

Coal mining is confined to the recreation area where coal is recovered from the Clarion and Kittanning seams by strip methods. There has been no deep mining for more than 10 years. The Brookville bed which underlies all of the proposed recreation area and a considerable portion of the reservoir is too thin to mine. Acquisition of coal rights would add approximately $730,000 to the cost of the project.

Oil has been produced in the area for more than one hundred years. Active and abandoned wells are numerous in both the reservoir and recreation areas. Acquisition of oil and gas rights and the plugging of wells would add approximately either $2.79 million or $3.88 million to the cost of the project, depending on the plan adopted.

The total cost of acquiring coal reserves and oil and gas wells and leases is estimated to be either $3.51 million or $4.60 million.

Recent transactions by private companies and governmental agencies provided basic figures for mineral evaluation. If the project is approved and implemented, a detailed reappraisal should be made to determine mineral values for specific parcels of coal land and oil and gas wells.

1/ Mining engineer, Pittsburgh Office of Mineral Resources, Bureau of Mines, U.S. Department of the Interior, Pittsburgh, Pa.

PURPOSE AND SCOPE

The proposed St. Petersburg Reservoir is intended to provide improved fish and wildlife habitat, flood control, water quality control, power generation, and recreation.

The proposed project consists of a dam, a reservoir, and a recreation area. The maximum pool elevation would be 1,144 feet above mean sea level with a maximum regulated summer pool at 1,110 feet and a maximum regulated winter pool at 1,101 feet. The normal summer drawdown level will be 1,090 feet above mean sea level.

The purpose of this investigation was to evaluate the mineral resources that would be affected by taking land for the reservoir and recreation purposes for the proposed project. A field investigation was made in April and May 1967. Seven days were spent examining the site area and interviewing residents of the area. Meetings were held with State agencies, and with coal and gas companies. Additional data were obtained from publications and Bureau of Mines records.

LOCATION (2, 5)[2/]

The St. Petersburg Reservoir would be on the Clarion River, 1/2-mile south of the village of St. Petersburg, in Clarion County, Pa. Except for 1/4 mile at the eastern end which would be in Jefferson County, the reservoir would lie entirely within Clarion County (fig. 4 - 21).

TOPOGRAPHY AND GEOLOGY

The proposed site is a part of the Appalachian Plateau region. The Clarion River has in comparatively recent time cut a deep, narrow, gorge across what was once a level surface. The smaller tributary streams have also deepened their valleys in a similar manner. Flood plains are narrow or absent and the farming area is on the gently undulating upland. Here the hills have rounded tops and gently sloping sides. Elevations do not vary greatly and the hills are roughly concordant in height. Stream-cut terraces and abandoned channels are well developed along the lower part of the Clarion River.

The rocks of the area are shale, sandstone, clay, limestone, coal, and alluvial deposits of sand and gravel. With the exception of coal, the rocks are composed of material that was transported and deposited by water and many of them were laid down in an ocean.

The exposed rocks belong to the Mississippian and Pennsylvanian Systems, and Pennsylvanian strata contain the coal seams of interest to this report. The Kittanning and Clarion coal seams are the

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2/ Underlined numbers in parentheses refer to items in the list of references at the end of this report.


Emlenton
VENANGO CO.
BUTLER CO.
VENANGO CO.
CLARION CO.
N
St. Petersburg
Foxburg
BUTLER CO.
ARMSTRONG CO.
PROPOSED DAM
CLARION RIVER
ALLEGHENY
RIVER
ARMSTRONG CO.
CLARION CO.
Turkey Run
Beaver Creek
Canoe Creek
1140' elevation
CLARION RIVER
Callensburg
1140' elevation
Cherry Run
Licking
Anderson Run
Sligo
Creek
1 1/2 0
Scale

FIGURE

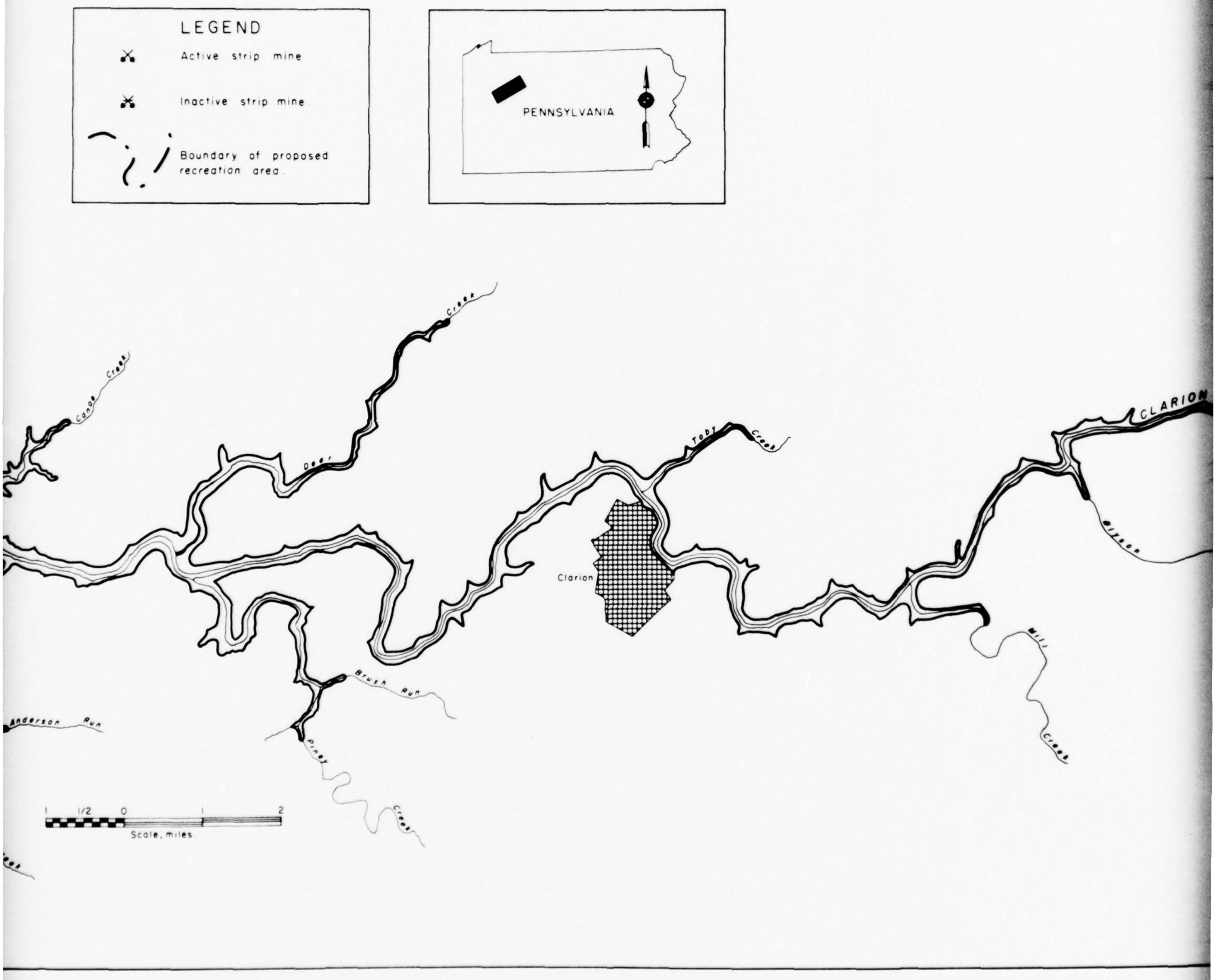

FIGURE 4 - 21. The Proposed St. Petersburg Reservoir Area.

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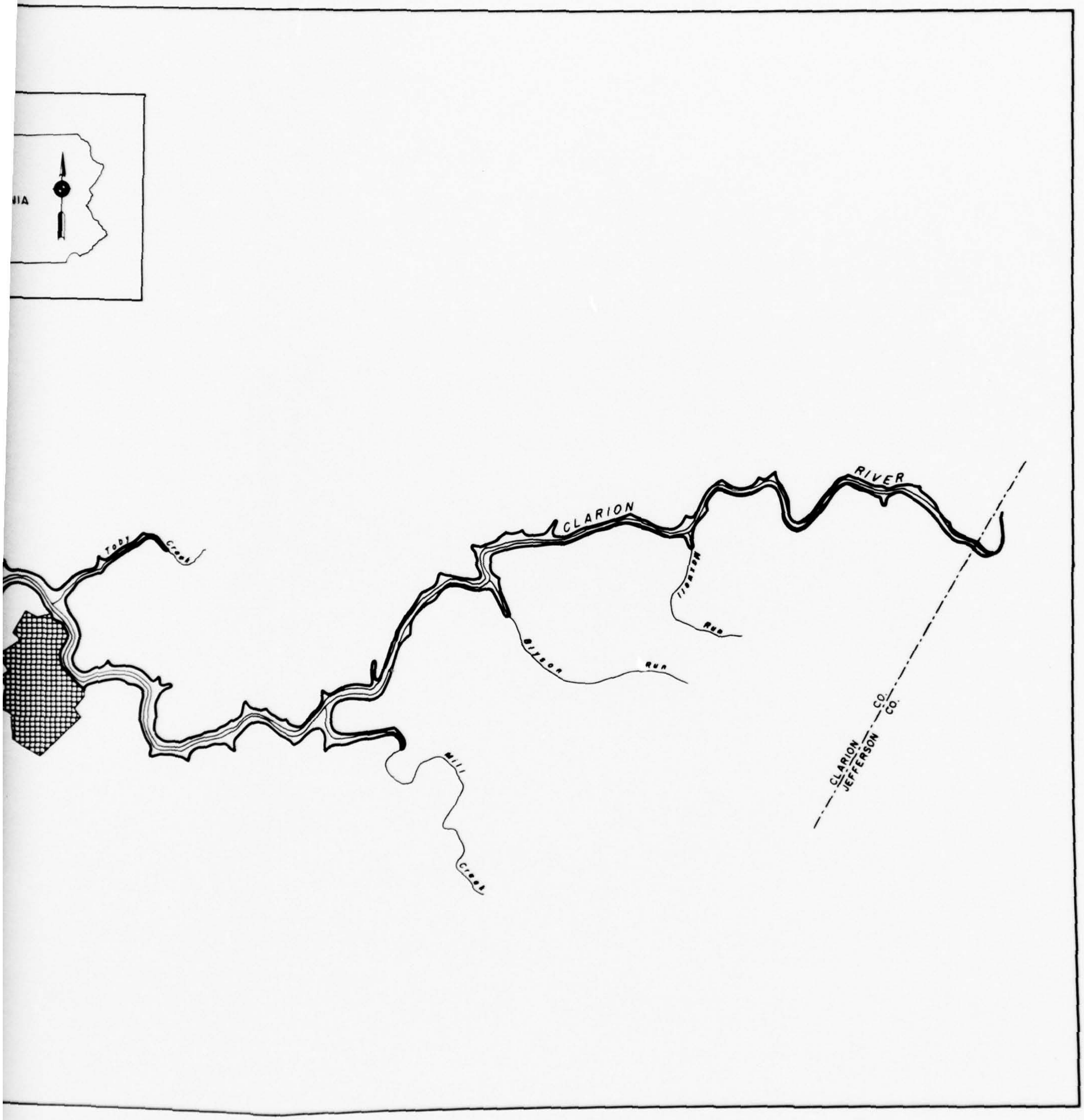

NIA
TOBY Creek
CLARION
RIVER
Run
Run
Mill
Creek
CLARION CO.
JEFFERSON CO.

roir Area.

important producing beds in the area. The Portage, Chemung, Catskill, and Oriskany Formations of the Devonian System have been penetrated in deep wells drilled for oil and gas. The unconsolidated gravels along stream valleys are of Quaternary age.

MINERAL RESOURCES (3)

Known mineral resources in the proposed site area are bituminous coal, oil and gas. The Kittanning and the Clarion are the most important producing coalbeds (figs. 4 - 22 and 4 - 23). Because of their thinness in the proposed project area, the Upper and Lower Freeport coal seams have been assigned no value. The Brookville seam underlies the entire site area but it also is too thin to mine economically. The minable coalbeds are mainly outside the proposed reservoir, but are important in the recreation area. During the past 10 years or more there has been no deep mining. Strip mining has been the method of coal recovery in recent years, with its related problems of reclamation, drainage, and formation of acid water.

In the recreation area, there is a reserve of 61 million tons of coal in the Clarion and Lower Kittanning seams of which about 16 million tons is strippable. The remaining 45 million tons which represent potential reserves would have to be recovered by deep mine methods. However, there has been no interest shown in deep mining in the area. Three small strip mining companies have been active in the recreation area and have produced 3.8 million tons of coal since 1952. However, a major coal company has acquired a large acreage in the eastern section of the recreation area and plans to start strip mining in the near future. The company has no plans for deep mining.

Oil and gas have been produced in the area since before the turn of the century. Most of the area has been thoroughly tested for gas and oil by drilling. According to the records made available by the Commonwealth of Pennsylvania and producing companies for this survey, the reservoir area contains a total of 347 wells of which 143 are abandoned, 60 are active oil wells, and 144 are active gas wells; in the recreation area, there are 337 abandoned wells, 46 active oil wells, and 87 active gas wells for a total of 470. According to these records the total for both areas is 817 wells. However, the records are incomplete and only a detailed and careful field survey would reveal the true number of wells in the proposed project area. There are two important reasons for this; (1) no records were kept of early drilling and (2) oil was the primary concern in the early drilling and a gas well was simply forgotten and the drill rig moved to another site, often only a few hundred feet away. The Commonwealth of Pennsylvania has made an effort to update its records of wells drilled, but gaps still exist. A group of abandoned wells was uncovered near Clarion, Pa., in 1967 by a strip coal mining operation. The location of this well field had not been recorded by the State and was not known to local residents. Locating and plugging abandoned wells in the reservoir area will be a major problem and will add materially to the final cost.

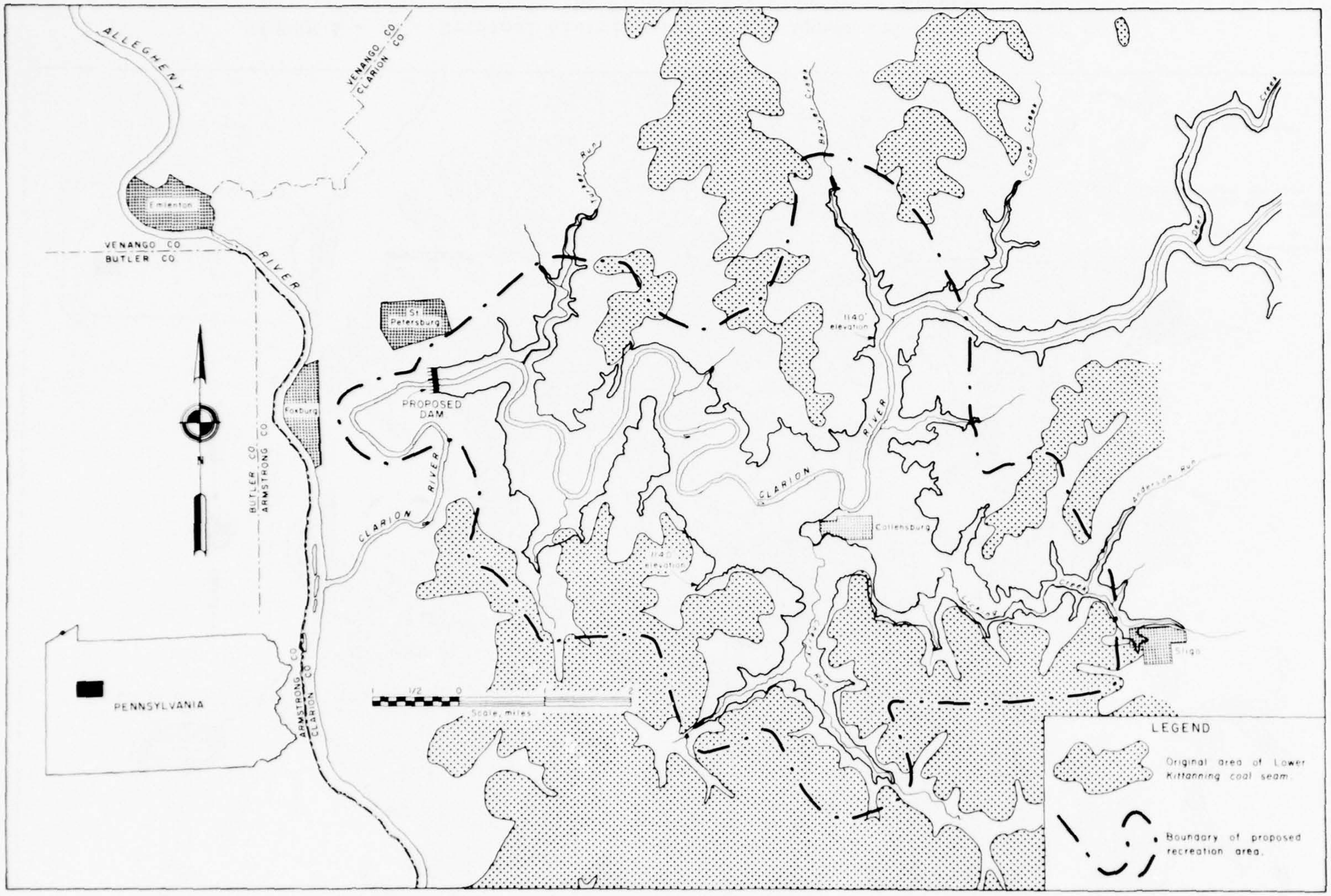


FIGURE 4 - 22. Original Distribution of the Lower Kittanning Coal Seam in the Proposed St. Petersburg Reservoir Area.

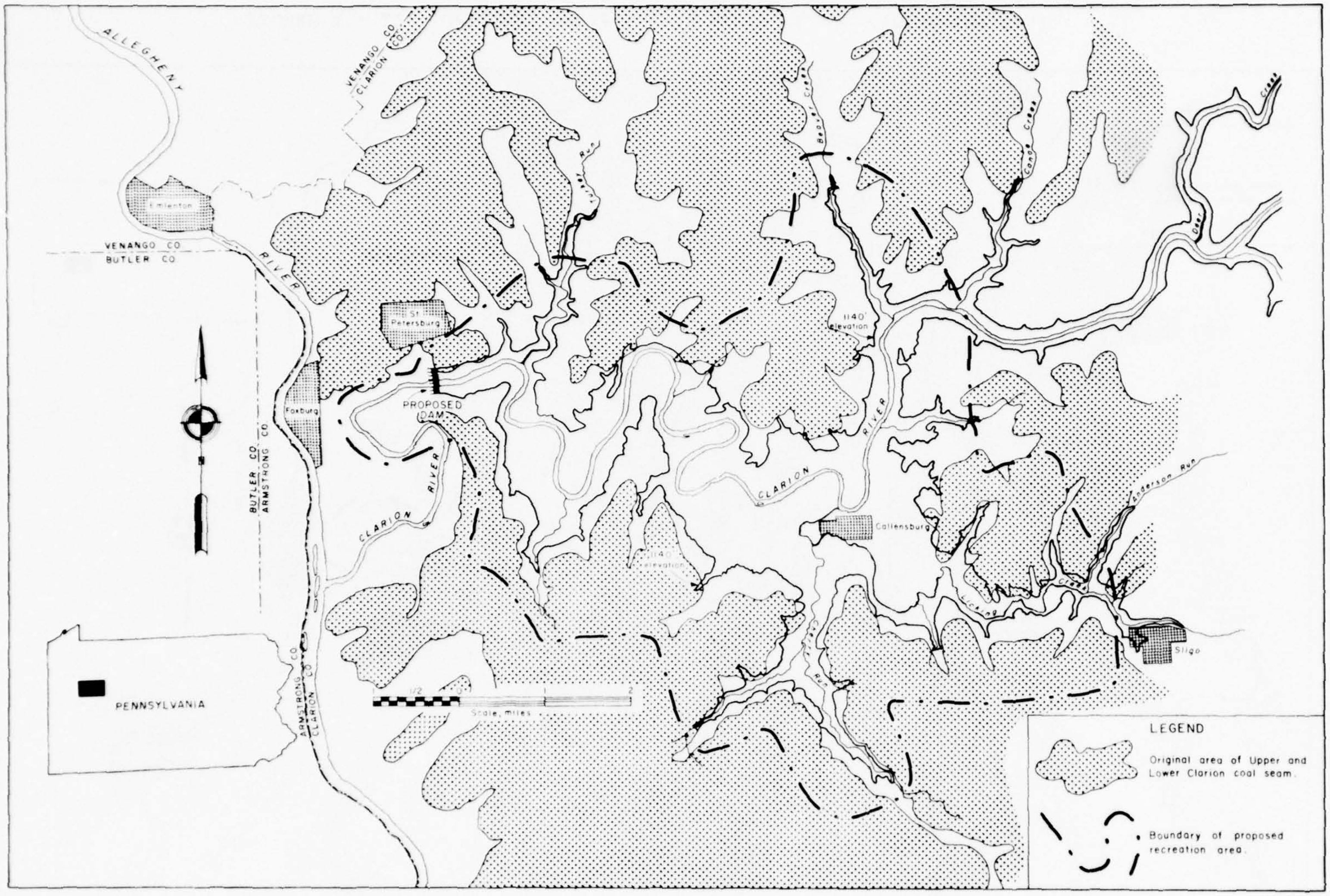


FIGURE 4 - 23. Original Distribution of the Upper and Lower Clarion Coal Seams in the Proposed St. Petersburg Reservoir Area.

Coal, oil, and gas play a major part in the economy of the surrounding area. An oil refinery at Emlenton depends entirely on the production of wells in the general area.

Clay, sand and gravel, and limestone are produced in the region but not within the proposed project area.

EVALUATION (3, 5)

Bituminous coal, oil, and gas are the only mineral commodities likely to influence the proposed project. The estimates of the cost of damage to the mineral industry are provisional figures because of limitations imposed by time and funding. The estimates are reasonable figures and may be used as a total but the estimated value per acre for coal in each category and for producing gas and oil wells are not recommended for use in acquiring land. If the project is approved and implemented, a detailed reappraisal should be made to determine mineral values for specific parcels of coal land and oil and gas wells.

Coal

Coal plays an important role in the economy of the region. In Clarion County alone, 20 mining companies are stripping coal at the rate of 3-1/4 million tons per year. There are five preparation plants operating from 280 to 320 days per year, but none is within the proposed project area.

Coal is mined from two seams, the Kittanning and Clarion, and hauled by trucks to loading ramps or preparation plants. The coal is used to make steam and does not approach metallurgical grade. Reserves of 700 million tons remain in Clarion County, but most of this reserve will have to be mined by underground methods. Three other seams of coal have been identified but are not being mined.

The coal of interest to the St. Petersburg project lies within the recreation area. In this area there is a reserve of 61 million tons in the Clarion and Lower Kittanning seams, including a strippable reserve of 16 million tons. Three mining companies have been active during the last 10 years. All mining has been by stripping and no underground development has been attempted. A major coal company has acquired a large acreage and plans to start strip mining in the near future.

The basic value of a coal deposit, as in any industry, depends upon market price vs. cost of production. Market price is determined by the demand for the quality of coal in question. Quality and demand determine price. Production costs depend on the mining method, thickness of overburden, thickness of coalbed, preparation requirements, transportation, and available reserves. In this area strip mining has allowed profitable production of coal. With the advent of larger equipment, there is a tendency to reopen old strip pits and uncover areas that would not have been profitable in the past. Underground mining is

not profitable. There has been no deep mining in the area for over 10 years nor any indication that deep mining will be resumed in the near future. However, deep mine coal is a potential reserve and has some future value.

A survey was made of county records of deed and assessed mineral rights for the years 1962-67. The "going rate" for strip coal land in fee simple was found to average $201.50 per acre in and near the project area. Mineral rights that have been separated from the surface are assessed separately. The Clarion County Assessor reported that all coalbeds are assessed as medium grade unless contrary evidence is available. The following table is a guide to assessments for separated coal rights.

Assessment rates per acre for coal rights
when separated from the surface -
Clarion County, Pa.

Coal Quality	All coal-beds owned	One coal-bed owned	Thickness of coalbed (inches)
Good	$50-350	$30-300	42 plus
Medium	$15-80	$10-60	30-41
Poor	$ 5-15	$ 5-10	24-29

In the recreation area, 4,000 acres contain Kittanning and Clarion coalbeds too deep to be mined by stripping. These are assumed to average 33 and 42 inches thick, respectively. There are 45 million tons of potential deep mine coal reserves in place, based on 1,800 tons of coal per acre foot.

There has been no deep mining in the project area during the last 10 years and no evidence that there will be any for the next 30 years. However, this coal represents a future value. If the coal rights remain with the surface rights and are not assessed separately, $5 per acre should be a generous estimate of future value. The value of 4,000 acres at $5 per acre is $20,000.

Records of coal land sales in fee simple indicated an average price of $201.50 per acre. Inasmuch as the surface must be disturbed by strip mining, and the owner must be compensated for this, the average fee simple value is used to calculate the cost of acquiring strippable coal. In the area involved there are 1,400 acres containing about 16 million tons of strip coal reserve. In acquiring strip coal reserves where no underground mining is being done, experience has shown that approximately an equal area of adjoining land usually must be purchased from the owner at the fee simple price because the owner decides the shape of the parcel he will sell.

2,800 acres at $201.50 per acre............$ 564,200

Cost of acquiring and holding strip coal
land (25 percent)........................ 141,050
Deep mine coal reserves.................... 20,000

Total cost of coal acquisition..........................$725,000
(rounded)

Gas and Oil (4, 6)

The proposed reservoir and recreation areas lie within the petroleum and natural gas region of western Pennsylvania. Thousands of wells have been drilled in the general area in search of new pools and in retesting old areas. Oil has been produced in the project area since 1865 when the first oil well was drilled on the Clarion River at the mouth of Deer Creek.

The productive acreage of the fields involved has been delineated and no extensive new development is anticipated.

Information concerning gas and oil wells was obtained from gas and oil companies, State and Federal agencies, and publications (2, 4-6). Well data from these sources are summarized in the following table.

Wells reported in the St. Petersburg reservoir
and recreation areas

Type of well	Reservoir area	Recreation area	Total
Active oil	60	46	106
Active gas	144	87	231
Abandoned	143	337	480
Total	347	470	817

Most of the oil is produced from the Venango sands (Devonian) at depths of 1,000 to 1,500 feet. Gas production comes from the Speechly sand (Devonian) at depths of 2,000 to 2,500 feet.

The number (480) of abandoned gas and oil wells reported is estimated to be half of the actual number (960) that may be found if a thorough search is made in the field. This is based on reported experience at nearby Moraine State Park. No records were kept of early drilling; and, with oil the primary objective, many gas wells and dry holes were abandoned unrecorded, and forgotten.

Due to lack of geological and engineering data, it is impossible to apply standard methods of engineering analysis to determine the remaining reserves in the area. A study was made of two of the gasfields

involved and of Clarion County as a whole. It is characteristic of wells in this area to continue to produce in small quantities for an indefinite number of years until the quantity obtained does not justify the cost of operation and maintenance. Statistical projections of future production are deceptive. Production of oil in the area averages 0.2 to 0.3 bbl per day per well. Average gas production is less than 10,000 cu ft per day per well. Historical production data is not available for the oil and gas wells within the project area.

The estimated value of the oil wells is based on the total oil production of Clarion County when projected to depletion under present operating procedures. The anticipated total production was averaged for the number of producing oil wells reported by the State Geological Survey as of December 31, 1965. The average production per well to depletion calculated from 1965 by projecting the declining rate of production is estimated to be 1,716 barrels. The estimated net annual return per well after deducting $1.00 per barrel for operating cost with oil at $4.45 per barrel would be $237 per year or $5,920 for the estimated 25 year remaining life. The present value of an annuity of $237 per year for 25 years at 5 percent is $3,340. The estimated daily rate of gas production is based on the average rate for all gas wells in Clarion County.

The average gas well is estimated to be capable of producing 10 mcf per day for 10 years. Based on a net return of $0.25 per mcf, the annual income per well would be $912.50. The present value of a 10-year annuity of $912.50 per year at 5 percent is $7,046.

The average cost of $1,000 each for plugging gas and oil wells is derived from estimates by State agencies and gas and oil companies.

Two plans for acquisition of oil and gas properties are presented.

Plan No. 1 - Plugging all wells (active and abandoned) in both the reservoir and recreation areas.

Acquire all active gas wells	$7,046 x 231 =	$1,627,626
Acquire all active oil wells	3,340 x 106 =	354,040
Acquire all surface operating equipment	1,500 x 337 =	505,500
Plug acquired wells	1,000 x 337 =	337,000
Plug abandoned wells	1,000 x 960 =	960,000
Acquire unproven gas and oil rights - 2,000 acres	50 x 2000 =	100,000
	Total................	$3,884,166
	Use..................	$3,880,000

Plan No. 2 - Continue company operation of active oil and gas wells in the recreation area; and plug all other oil and gas wells in both areas.

Acquire active gas wells in reservoir area	$7,046 x 144 =	$1,014,624
Acquire active oil wells in reservoir area	3,340 x 60 =	200,400
Acquire surface operating equipment in reservoir area	1,500 x 204 =	306,000
Plug wells acquired	1,000 x 204 =	204,000
Plug abandoned wells	1,000 x 960 =	960,000
Acquire unproven gas and oil rights - 2,000 acres	50 x 2000 =	100,000
	Total....................	$2,785,024
	Use......................	$2,780,000

The total cost of acquiring coal reserves and oil and gas wells and leases is estimated to be either $3.51 million or $4.60 million.

RECOMMENDATIONS

The Bureau of Mines recommends that strip mining and the production of oil and gas in the recreation area be allowed to continue as provided in the agreement of February 19, 1962, between the Secretary of the Interior and the Secretary of the Army. Production of these minerals plays an important part in the local economy.

Strip mining followed by proper surface reclamation could be of interest to visitors, enhance the outdoor recreation potential of the area, and allow recovery of the coal. Full use of the recreation potential will require abatement of acid pollution in many tributaries of the Clarion River.

REFERENCES

1. Ashley, G. H. The Valuation of Public Coal Lands. U.S. Geol. Survey Bull. 424,1910, pp. 8-14.

2. Bergsten, J. M., and L. A. Heeren. Oil and Gas Field Atlas of the Foxburg Quadrangle, Pa. Pennsylvania Geol. Survey, Fourth Series, Special Bulletin 9, 1961, 26 pp.

3. Blaylock, D. W., J. J. Dowd, R. F. Abernethy, and D. A. Reynolds. Estimate of Known Recoverable Reserves of Coking Coal in Clarion County, Pa. BuMines Rept. of Inv. 5231, 1956, 25 pp.

4. Lytle, W. S., J. H. Goth, Jr., D. R. Kelley, W. G. McGlade, and W. R. Wagner. Oil and Gas Developments in Pa. in 1965. Progress Report 172, 1966, pp. 24, 51, 54.

5. Shaw, E. W., and M. J. Munn. Foxburg-Clarion, Pa. U.S. Geol. Survey, Folio No. 178, 1911, 127 pp.

6. U. S. Geological Survey. Coal, Oil, and Gas of the Foxburg Quadrangle, Pa. U.S. Geol. Survey, Bull. 454, 1911, 85 pp.

MINERAL RESOURCES
IN
THE PROPOSED CLARION RIVER SCENIC AREA
COOKSBURG, PA. TO RIDGWAY, PA.

SUPPLEMENT

TO

MINERAL RESOURCES
IN
THE PROPOSED ST. PETERSBURG RESERVOIR AREA
CLARION RIVER BASIN, PA.

PROPOSED PROJECT

The Clarion River from Ridgway, Pa., westward to its confluence with the Allegheny River, has been designated for potential addition to the national wild and scenic rivers system. In an extension of coordination under the Water Resource Survey for Appalachia this report is a supplement to "Mineral Resources in the Proposed St. Petersburg Reservoir, Clarion River Basin, Pa.". The St. Petersburg study was extended to include the mineral resource potential for the Clarion River Scenic area from Cooksburg, Pa., to the vicinity of Ridgway. Between these two points the river flows through parts of Forest, Jefferson, and Elk Counties.

Material for the supplement was taken entirely from published data and from interviews with knowledgeable individuals. No field work was undertaken. If the program is to be implemented a field survey should be made.

The study is to determine the status of the mineral industry in this section of the Clarion River, the possible loss of mineral resources if the land along the river is withdrawn from mining, possible future use of the mineral resources, and conditions caused by the mineral industry that would add to or detract from the natural beauty of the river.

TOPOGRAPHY AND GEOLOGY

The Clarion River is within the Appalachian Plateaus physiographic province. It occupies a deep, narrow, gorge in a region with rolling flat-topped hills which represent the remnants of an old peneplain. Tributary valleys along the river have steep, rugged slopes. Relief in the area ranges from 1,150 feet in the Clarion River valley to over 2,200 feet on some hilltops.

Rocks exposed in the area are of Mississippian and Pennsylvanian age (fig. 4-23a). The Clarion River gorge cuts the massive sandstone beds of the Mississippian Pocono Formation. In this area of western Pennsylvania the overlying Mauch Chunk Formation is not present. The Pennsylvanian Pottsville Formation, the most widespread formation in the area, is composed of sandstone, shale, clay, and thin coalbeds. Overlying the Pottsville is the Allegheny Formation containing the important coal seams of this part of Pennsylvania. The Allegheny is present only as scattered remnants capping a few of the hills north of the Clarion River, increasing in thickness and areal extent west and south of the study area. Rocks of the Conemaugh Formation are found on the hills along Little Toby Creek south of the Clarion River.

MINERAL RESOURCES

Coal

The stretch of the Clarion River investigated lies north of the northern edge of the main bituminous coalfield of Pennsylvania. All of the upper coals have been eroded. Remnants of the Conemaugh Formation are left capping the hills along Little Toby Creek; coalbeds in these remnants are thin and noncommercial. The Allegheny Formation, containing the principal coal seams in the area, has been eroded north of the Clarion River except for limited areas on some hilltops. About 8 miles south of the Clarion River the Allegheny becomes thicker and more extensive. The Lower Kittanning coalbed along Little Toby Creek in this area has been extensively deep mined. Most of the deep mines have been abandoned and acid drainage from these mines flows into Toby Creek and thence into the Clarion River.

No coal mines are presently operating along this stretch of the Clarion and none has operated within the last five years. Strip mining and some deep mining is currently being done along Little Toby Creek.

Along the Clarion River the Pottsville Formation contains three noncommercial coal seams. Locally known as the Alton coals, these seams are generally thin, and are high in sulfur and ash.

Coal resources would not likely be affected by withdrawal of land along the Clarion River under the "Wild and Scenic Rivers" Act.

Oil and Gas

Oil and gas activity along the stretch of the Clarion River considered is confined to the shallow gas formations (Upper Devonian or younger). Three new gas wells have been reported since 1965 in an old established gasfield near the Clarion-Jefferson-Forest County junction (fig. 4-23b). These wells were drilled on the south slope above the Clarion River. No new wells have been reported in recent

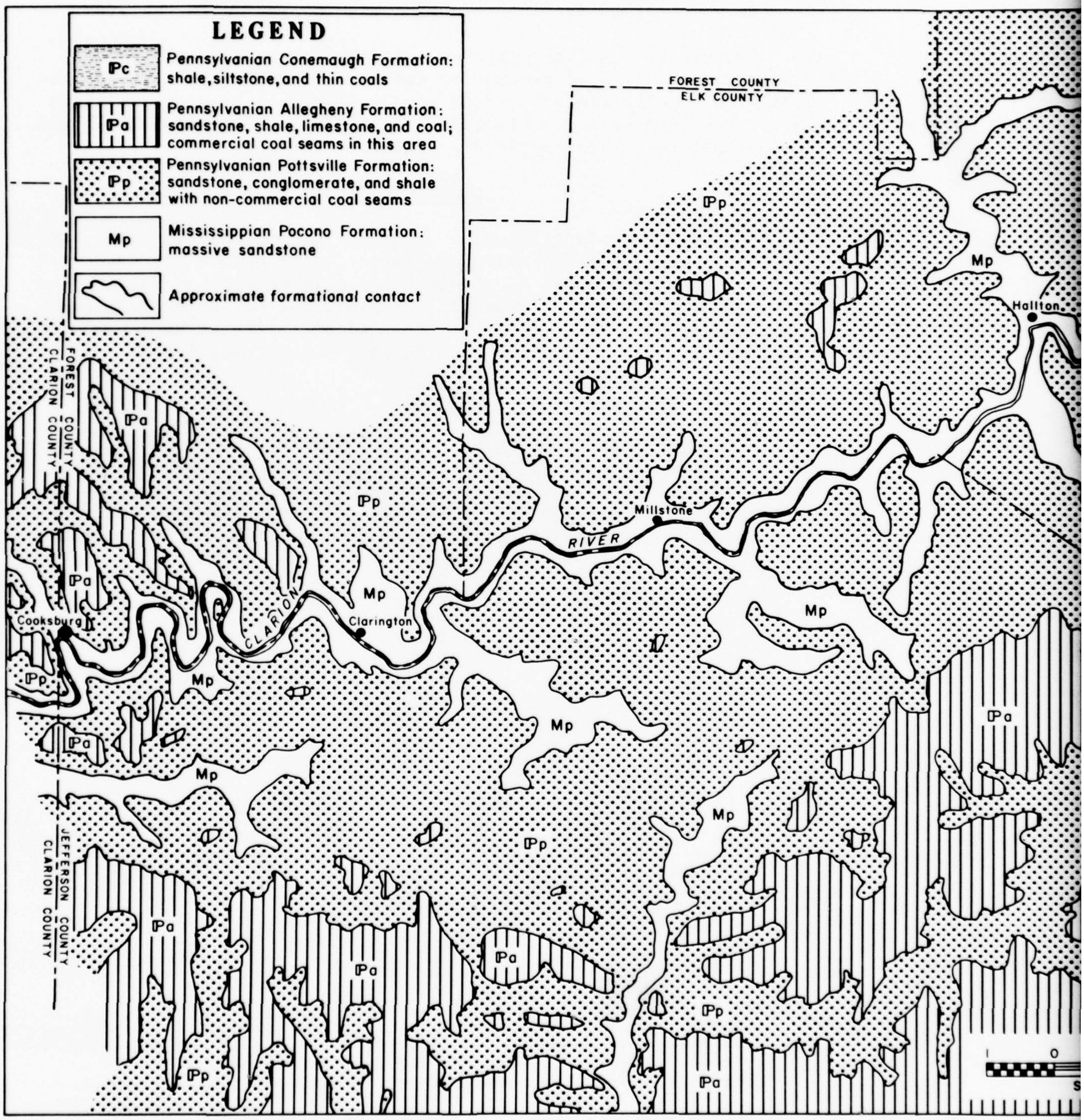
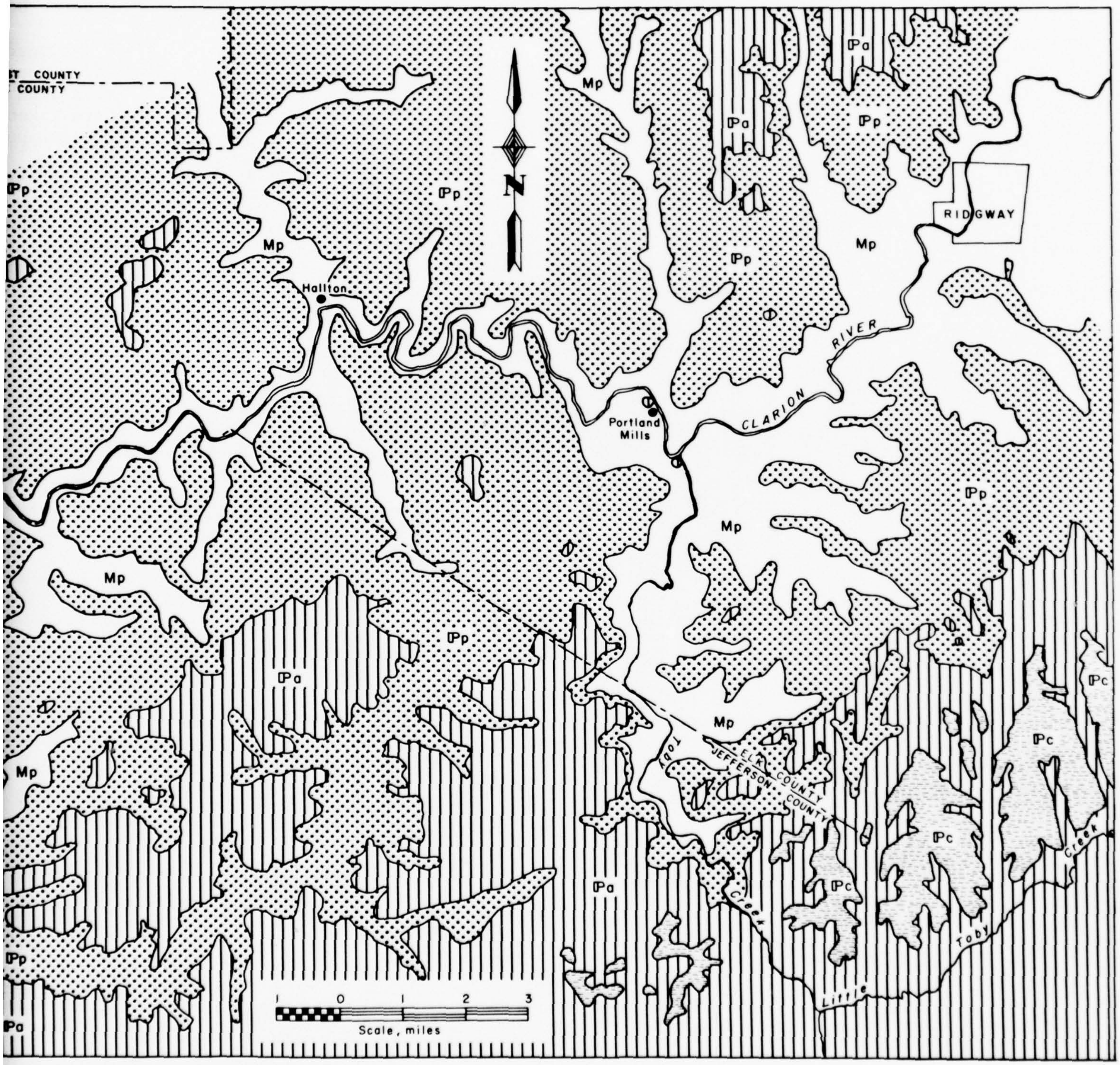


FIGURE 4 - 23a. - General Geology along the Clarion Ri



· General Geology along the Clarion River, Cooksburg to Ridgway, Pa.

2

years from another established shallow gasfield east of Millstone, Pa. Information on older producing wells and plugged abandoned wells would have to be obtained from individual companies active in the area.

Coordination of the petroleum industry with the study could assure continuation of present or future oil and gas activity in the area with no detrimental effects on the scenic quality of the river. Care taken in drilling activities and plugging abandoned wells would prevent pollution and scenic disruption.

Limestone

Although important in other areas of western Pennsylvania, the Vanport Limestone in the Allegheny Formation is either not present or is too thin to be mapped as a unit along this section of the Clarion River. Thin beds in the area will likely never be commercial, as Vanport Limestone reserves of 15- to 20-foot thickness have been estimated at over 19 billion tons in five nearby counties[1].

Other

Although sandstone, shale, and clays are present in abundance in the Clarion River area investigated, no particularly valuable deposits have been noted. All of these materials are available closer to centers of use and it is not likely that economically important sandstone, shale, and clay resources would be lost through the program.

1/ O'Neill, Bernard J., Jr. Atlas of Pennsylvania's Mineral Resources, Part 1. Limestones and Dolomites of Pennsylvania. 1964, p. 8.

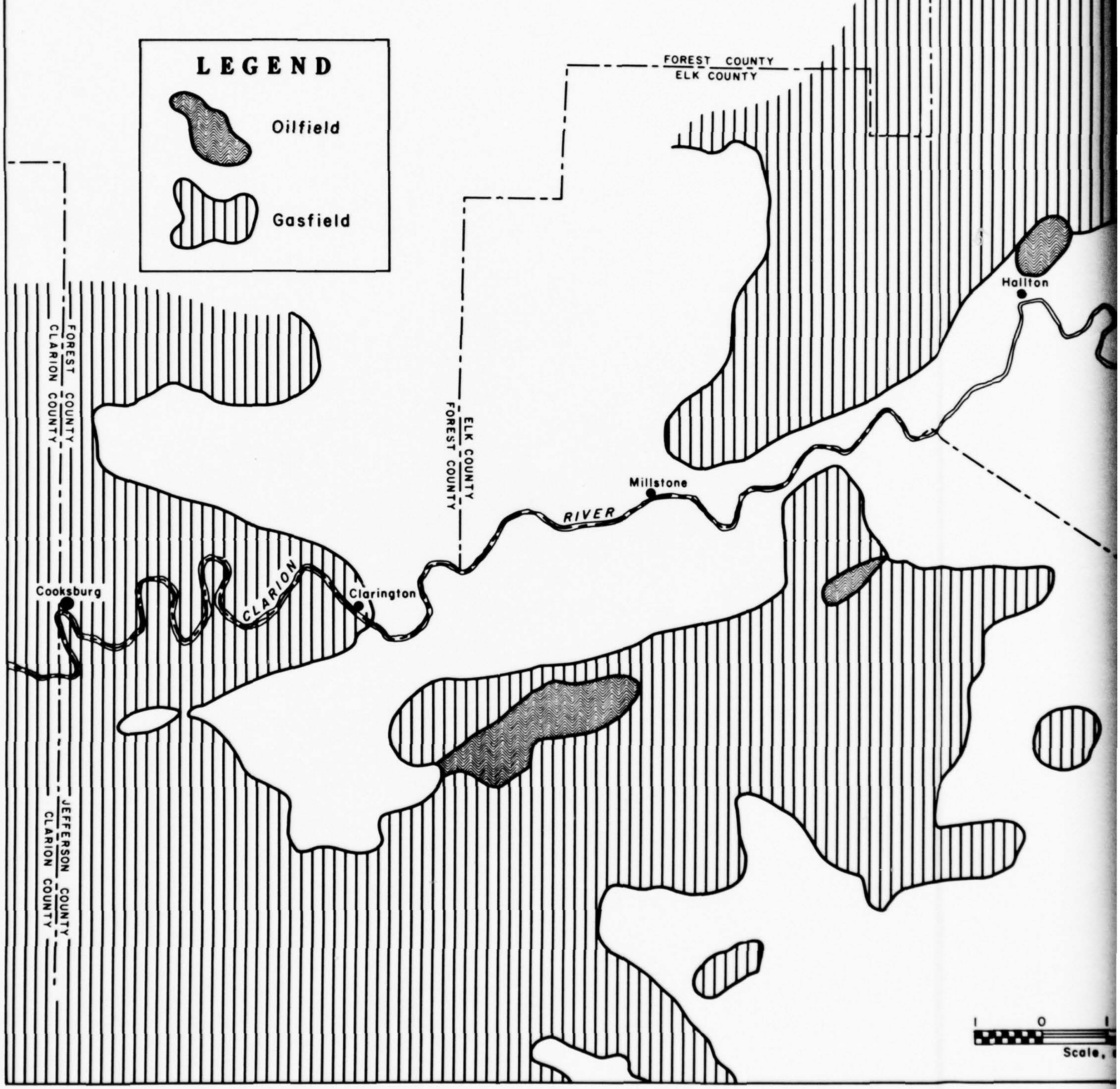
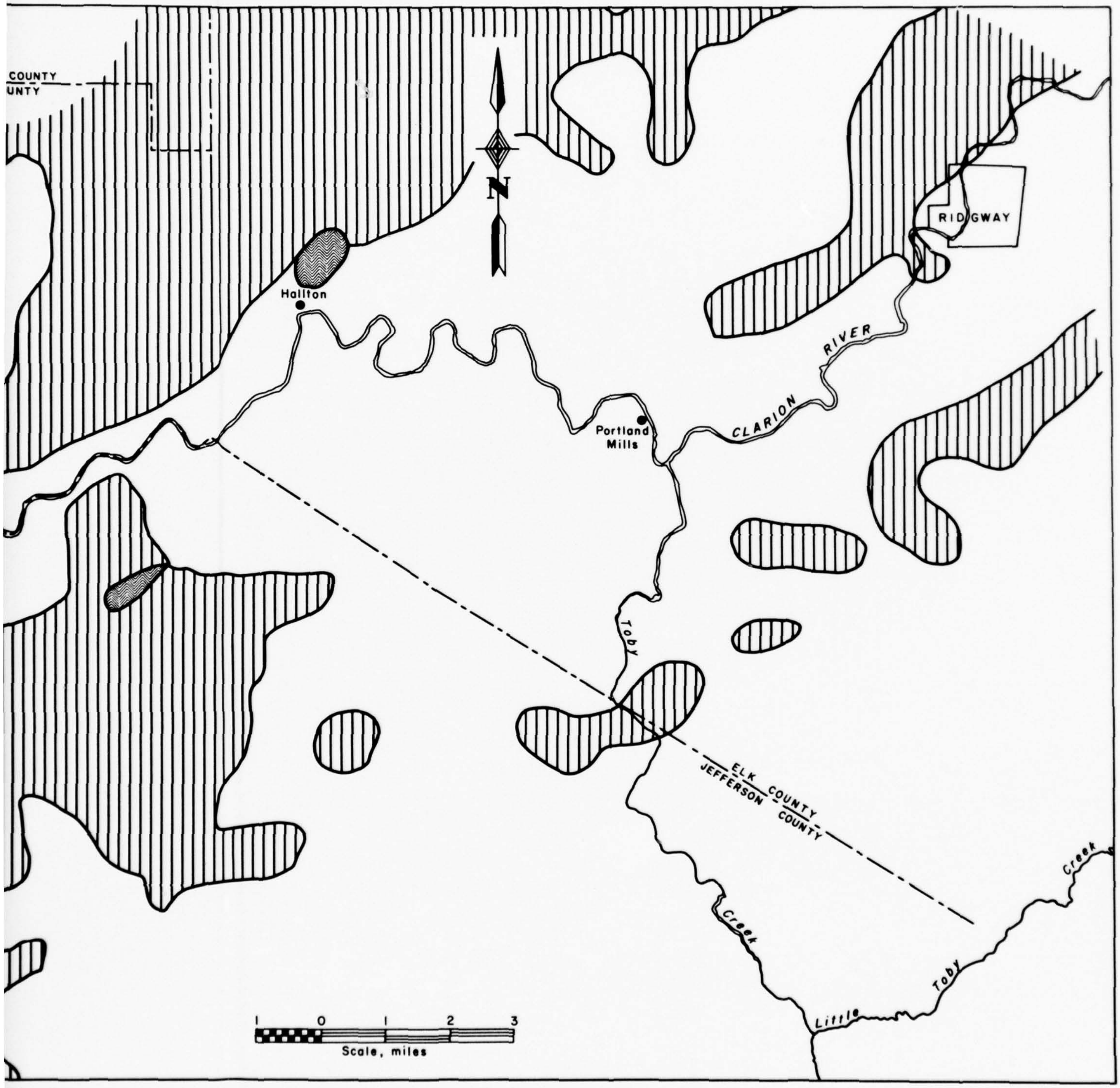


FIGURE 4 - 23b. - Oil and Gas Fields, Clarion River, Coo



- Oil and Gas Fields, Clarion River, Cooksburg to Ridgway, Pa.

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MINERAL RESOURCES
IN
THE PROPOSED STANNARD RESERVOIR AREA
GENESEE RIVER BASIN, N. Y.

by

C. Gordon Leaf[1/]

ABSTRACT

The Stannard Dam and Reservoir, proposed by the Buffalo District, U.S. Army Corps of Engineers, would be on the Genesee River in Allegany County, N. Y. A study of the mineral resources of the area by the Bureau of Mines indicated that no known mineral operations are within the proposed reservoir area and it is unlikely that any important mineral resources will be lost as a result of dam and reservoir construction.

A double-line natural gas pipeline owned by Consolidated Gas Supply Corp., Clarksburg, W. Va., crosses the proposed reservoir area. This line would have to be relocated or modified for underwater service.

PROPOSED WATER DEVELOPMENT PROJECT

The Stannard Dam and Reservoir, proposed by the Buffalo District, U.S. Army Corps of Engineers, is intended to provide improved fish and wildlife habitat, recreation for the Wellsville, N. Y., area, flood control on the Genesee River, water quality control, and power generation.

Spillway design flood pool elevation would be 1,625 feet above mean sea level, and maximum conservation pool elevation would be 1,593 feet. At elevation 1,593 feet the reservoir area would be 1,510 acres. Maximum flood pool elevation of 1,620 feet would extend the reservoir 1-1/2 miles past Genesee, Pa., and northeastward back into New York along Cryder Creek (fig. 4 - 24).

A levee would be constructed at the divide between Honeoye and Marsh Creeks at the terminus of the southwest arm of the reservoir (fig. 4 - 24) to prevent loss of water into the Allegheny watershed.

1/ Geologist, Pittsburgh Office of Mineral Resources, Bureau of Mines, U.S. Department of the Interior, Pittsburgh, Pa.

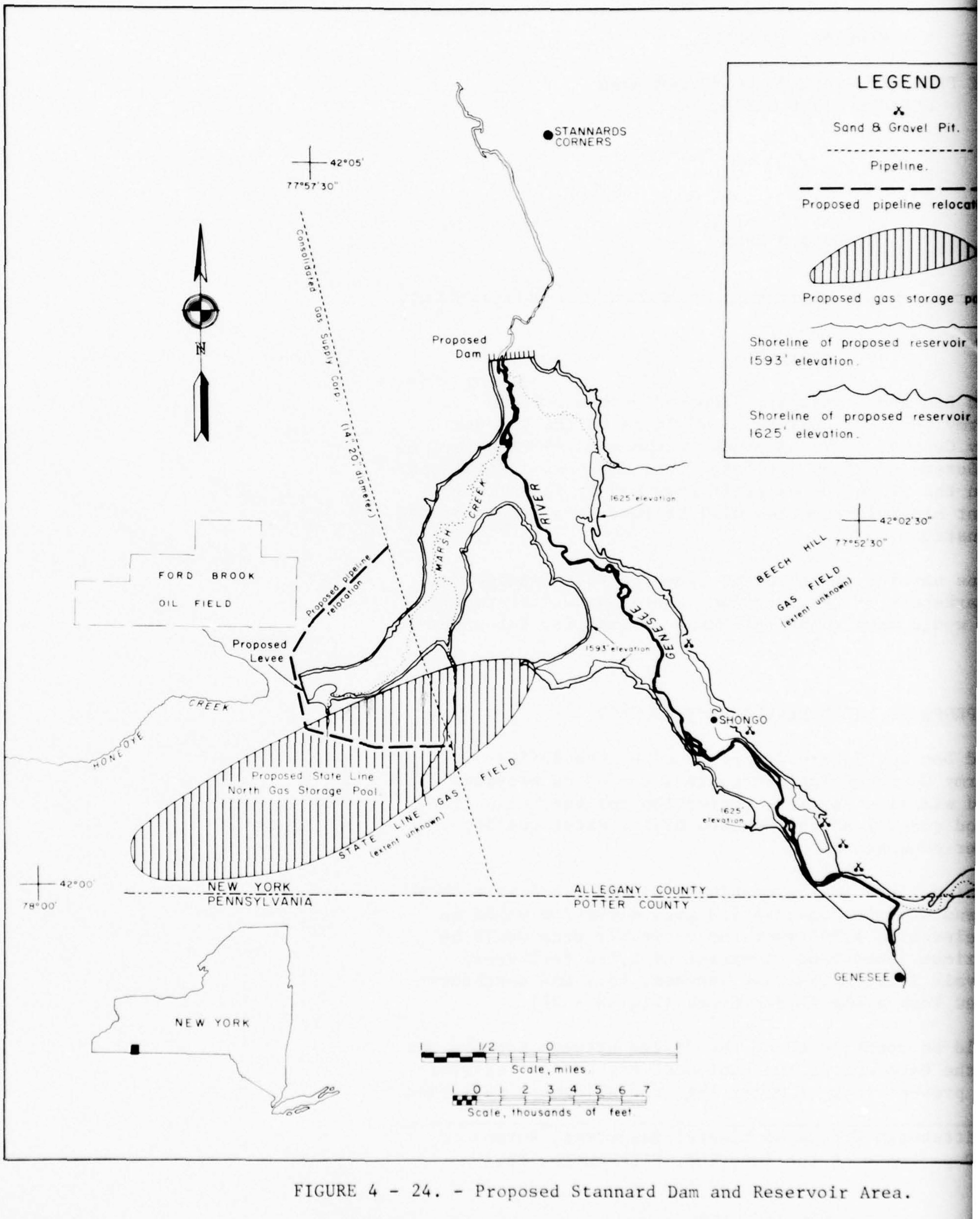

FIGURE 4 - 24. - Proposed Stannard Dam and Reservoir Area.

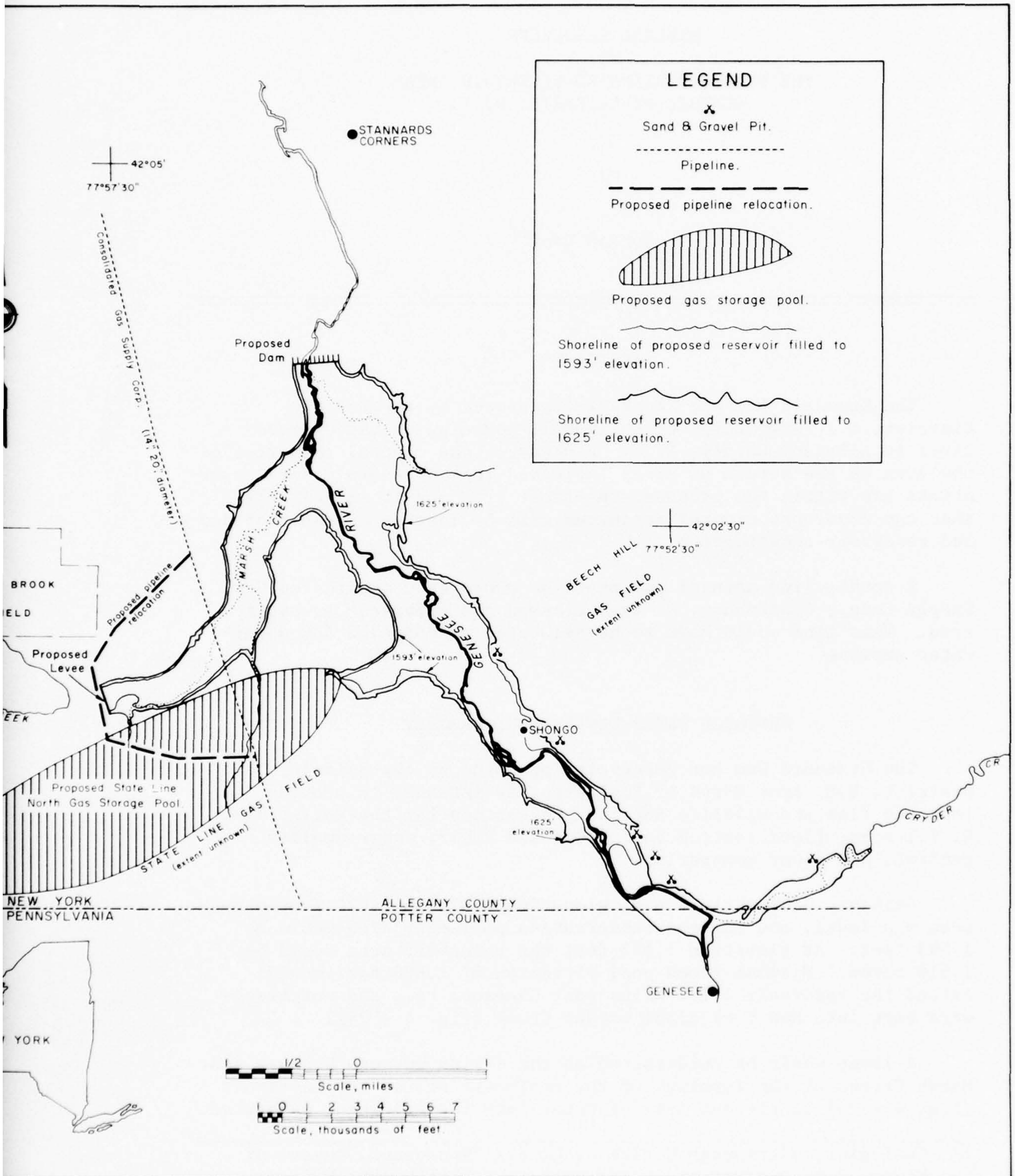

FIGURE 4 - 24. - Proposed Stannard Dam and Reservoir Area.

The Bureau of Mines field investigation was done in March 1967. Three days were spent in the field examining the area and interviewing local residents.

LOCATION

The proposed Stannard site would be on the Genesee River 2 miles south of the village of Stannards Corners in Allegany County, N. Y. The reservoir would lie principally within Allegany County, N. Y., and extend into Potter County, Pa.

TOPOGRAPHY AND GEOLOGY

The Stannard area is a part of the Allegheny Plateau region of the Appalachian Province. Topography shows the characteristic ruggedness of the high hills and steep valleys of southwestern New York. This has been produced by the erosion of streams cutting through alternating layers of hard sandstones and soft shales, and modified in most of the area by Pleistocene glacial activity. In a few places, as in Honeoye and Cryder Creeks, the steep-sided valley walls tower hundreds of feet above the valley floor, but along the Genesee River the surface rises gradually from an elevation of about 1,600 feet to more than 2,300 feet above sea level on knobs which are the remnants of a dissected plateau (2)[2/].

Bedrock in the area is shale and thin-bedded sandstone of Upper Devonian age. Glacial deposits covering the hills consist of a veneer of till no more than a few feet thick. In the valleys fluvioglacial sand and gravel deposits are many tens of feet thick. The valley deposits are seen as benchlike structures with nearly flat surfaces, bordering one or both sides of the lower valleys in the area (2).

A small part of the area is not drained by the Genesee River. About 2 square miles in the southwest section are drained by Honeoye Creek, a tributary of the Allegheny River (2).

MINERAL RESOURCES

Mineral resources present in the vicinity of the proposed site are oil and gas, sand and gravel, clay, and sandstone. No active wells, mines, pits, or quarries are known to be within the proposed reservoir area.

Sand and gravel is available in all the major valleys and a number of pits are operated intermittently north of Genesee, Pa.

2/ Underlined numbers in parentheses refer to items in the list of references at the end of this report.

These pits are outside of the proposed reservoir area and contain no washing or crushing equipment. The material is used only for fill.

Clay used in making brick and tile has reportedly been produced in the area but it is of mediocre quality and is not currently being mined (2).

Flagstone has been quarried and "picked up" locally for patios, fireplaces, and foundations, but there are no known quarries active in the area at this time.

Petroleum and natural gas is of leading importance in the Stannard area, although production has declined. No known wells are within the proposed reservoir area, but information is lacking on locations of many of the early wells. The reservoir would lie between two major gas producing fields in the area, the Beech Hill field to the northeast and the State Line field to the southwest (fig. 4 - 24). Depth to the gas producing Oriskany Formation is 4,600 to 4,900 feet (1).

Two companies have control of much of the area: Consolidated Gas Supply Corp. in the State Line field and Sylvania Corp. in the Beech Hill field. Numerous individuals also own or control leases along the Genesee River.

A double-pipeline (14 and 20 inches) crosses the southwestern arm of the proposed reservoir. These lines are owned by Consolidated Gas Supply Corp. of Clarksburg, W. Va. Construction of the dam and reservoir would necessitate relocation or modification of the pipelines. If feasible, modification of the lines would be cheaper than relocation.

A proposed gas storage pool will be near the area that would be inundated (fig. 4 - 24). This storage pool would not affect the reservoir because the storage wells would be 4,600 to 4,900 feet deep.

Other than causing relocation or modification of the pipelines, the proposed water development project would have no adverse effect on the mineral industry of the area. Although no production is known to have occurred within the proposed reservoir area, a study should be made to determine whether any unplugged wells are within the area. Oil and gas leases within the area of taking should not greatly affect the cost of acquiring this land.

CONCLUSIONS

The proposed Stannard Dam and Reservoir site does not conflict with any known mines, quarries, or wells, and no known mineral

resources are likely to be lost as a result of the dam and reservoir construction.

Consolidated Gas Supply Corp.'s double-line natural gas pipeline which crosses the proposed reservoir area would have to be relocated or modified for underwater service. Modification of the pipelines in their present location, if feasible, would be cheaper than relocation.

REFERENCES

1. Kreidler, William Lynn. History, Geology and Future Possibilities of Gas and Oil in New York State. New York State Museum, Circ. 33, 1953, 58 pp.

2. Woodruff, John G. Geology of the Wellsville Quadrangle. New York State Museum, Bull. 326, 1942, 135 pp.

MINERAL RESOURCES
IN
THE PROPOSED ZOAR VALLEY RESERVOIR AREA, N. Y.

by

Lawrence Y. Marks[1/]

ABSTRACT

A multipurpose reservoir project about 6 miles upstream from Gowanda, N. Y., on Cattaraugus Creek has been proposed by the Buffalo District, U.S. Army Corps of Engineers. At this Zoar Valley site, Upper Devonian siltstone and shale are overlain by glacial till and stratified drift. A natural gas storage field, operated by Iroquois Gas Company, would be affected adversely by the proposed project. Pipelines carrying natural gas and oil products also would need to be modified due to the project. Minable sand and gravel deposits occur in the area, but are not expected to affect land acquisition costs significantly. A premixed concrete plant may need to be relocated, although it is outside the proposed 1,200-foot pool area.

INTRODUCTION

The Bureau's function is to assist the Corps of Engineers by estimating the influence of mineral resources and the mineral industries upon the proposed water development project. The maximum flood pool originally proposed was at an elevation of 1,200 feet. Later, the Corps requested that pool elevations of 1,150 feet and 1,130 feet be considered and the Bureau has revised its study accordingly.

ACKNOWLEDGMENTS

Sources of data used in this evaluation include: 1. Location and extent of the proposed project supplied by the Buffalo District, U.S. Army Corps of Engineers, 2. Topographic maps prepared by the U.S. Geological Survey (4)[2/], 3. The geological map of New York

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2/ Underlined numbers in parentheses refer to items in the bibliography at the end of this report.

State (2), 4. A surficial geology map (1), 5. Location maps of gas storage wells and connecting pipelines furnished by New York State Division of Water Resources and Iroquois Gas Company, 6. Discussions with personnel of the New York State Conservation Department, Division of Water Resources, Iroquois Gas Company, Tennessee Gas Pipeline Company, and Ashford Concrete Company, and 7. Field observations were made by the author during March 1967.

Because little information concerning natural gas and petroleum reserves and transmission can be obtained by field observation, data supplied by personnel of the New York State Division of Water Resources and the above-mentioned companies were used extensively in this evaluation.

PROPOSED WATER DEVELOPMENT PROJECT

The Zoar Valley Reservoir is proposed as a multipurpose project which would provide flood control for Gowanda, N. Y., improve the quality of water downstream from the project, store water for industrial, domestic, and agricultural use, and support water oriented recreation. The reservoir would be about 15 miles long at a maximum pool elevation of 1,200 feet.

LOCATION

The dam would be on Cattaraugus Creek about 6 miles upstream from Gowanda, N. Y., with the reservoir in Erie and Cattaraugus Counties. The portion in Erie County would not be in Appalachia. Details of this area are shown on figure 4 - 25.

TOPOGRAPHY AND GEOLOGY

This site is located in the Appalachian Plateau physiographic province. Maximum relief is more than 1,000 feet from hilltops within 5 miles of the creek to the channel which is about 900 feet above sea level at the proposed damsite. Cattaraugus Creek flows through a narrow canyon about 200 feet deep in several places (4). Pleistocene glaciation has subdued some of the previously existing relief by eroding hills during stages of glacier advance and depositing till moraines and stratified drift as the ice sheet melted. Surficial deposits are of Pleistocene age and consist of glacial till--a mixture of broken rock fragments of various particle sizes--and well-sorted glacial outwash composed of sand and gravel. Till occurs over most of the area (1). Outwash is present on remnants of terraces which are as much as 400 feet above Cattaraugus Creek.

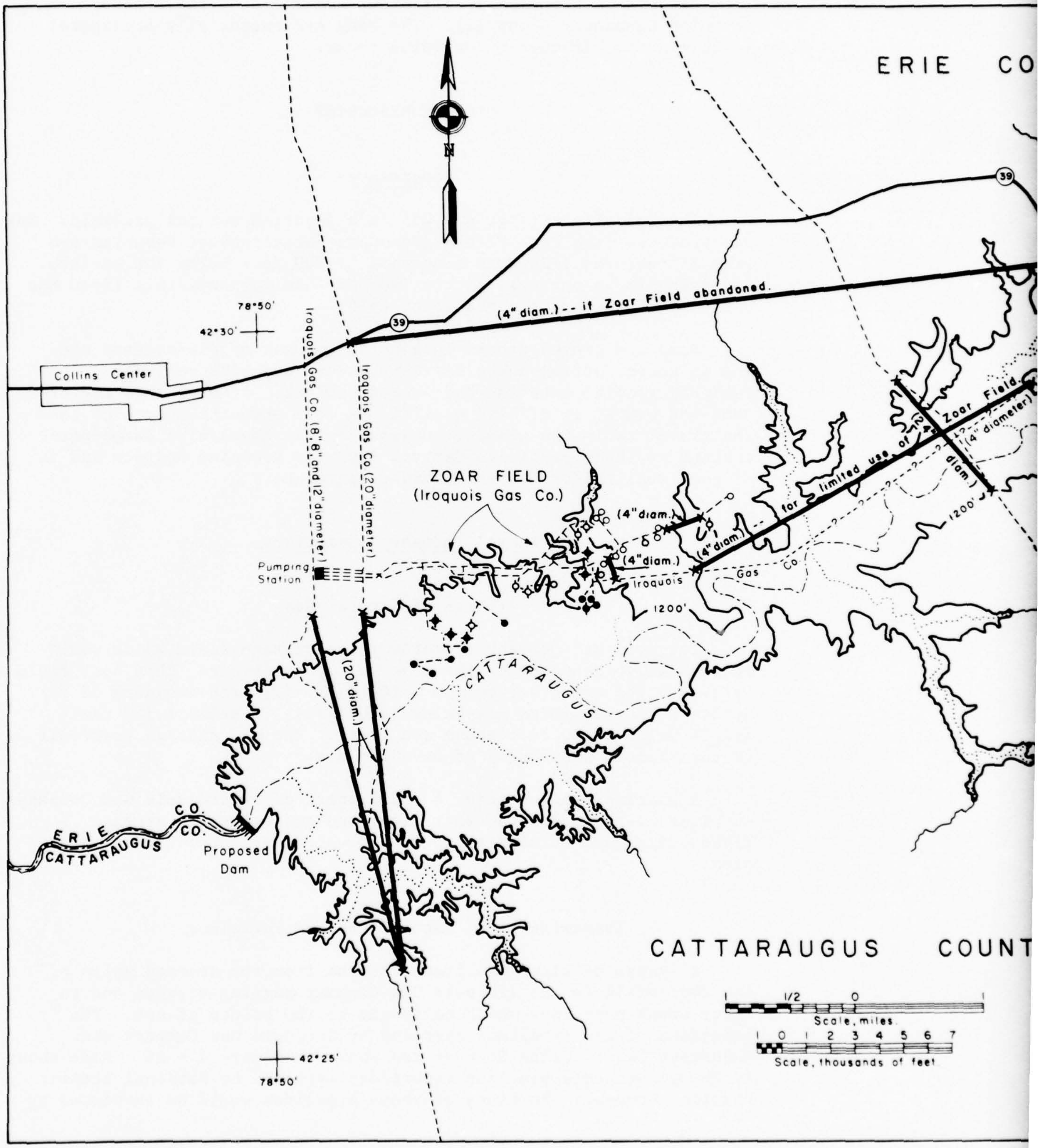
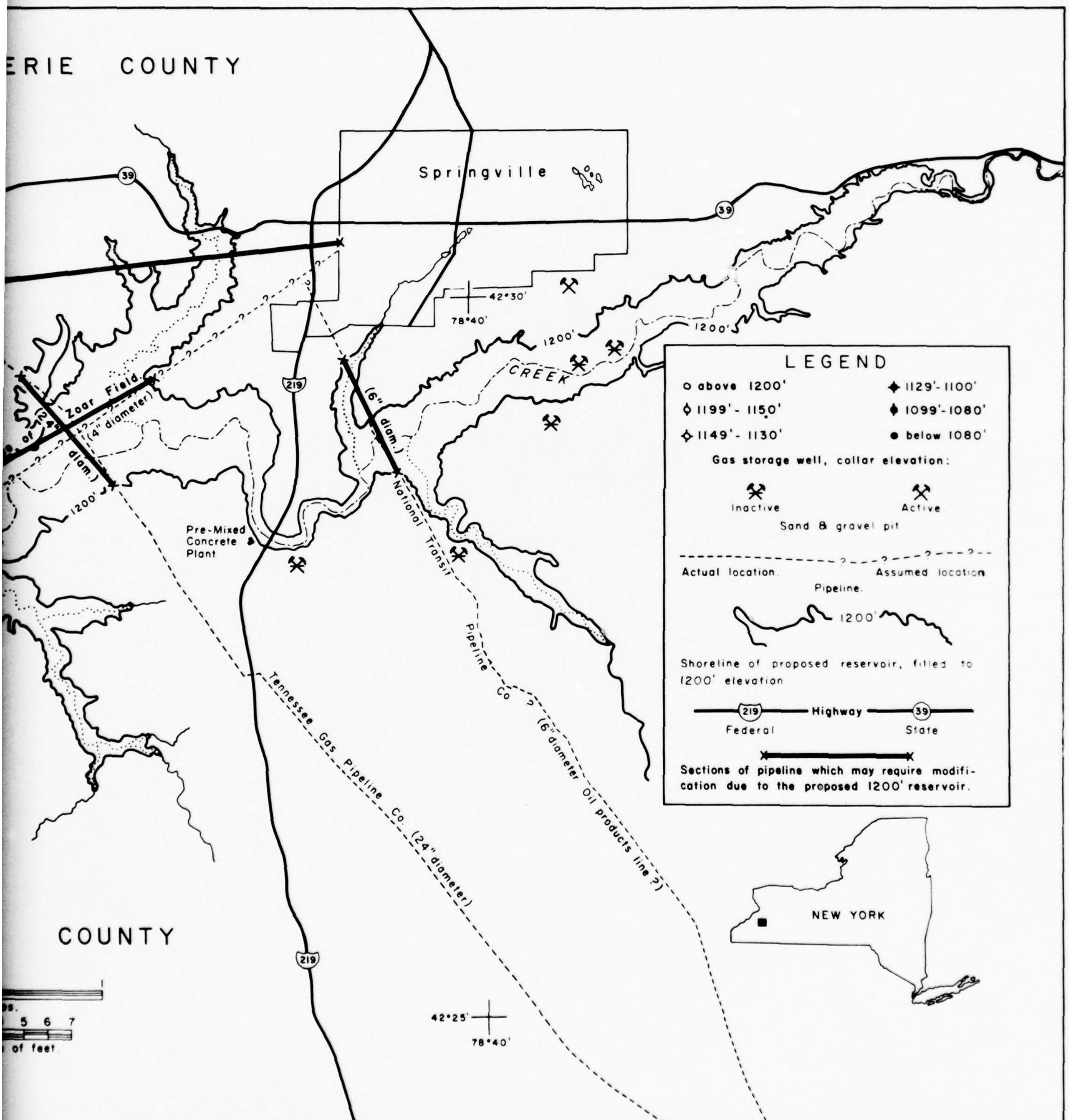


FIGURE 4 - 25. - The Proposed Zo



The Proposed Zoar Valley Reservoir Area.

2

Bedrock is principally siltstone and shale of the Upper Devonian Canadaway Group (2). The beds are essentially horizontal in this area, although minor folds occur.

MINERAL RESOURCES

Occurrence

The Zoar Field (fig. 4 - 25) is a depleted natural gasfield. Gas was produced from the "Flint" (Onondaga Formation) of Devonian age from a fractured limestone zone about 1,800 feet below the surface. According to an engineer of the Iroquois Gas Company, this field has been used for storage since about 1916.

Sand and gravel occurs in glacial outwash of Pleistocene age and in Recent stream deposits. The stream deposits comprise reworked glacial material and eroded bedrock. Some of this Recent sand and gravel is of high quality. A more abundant source of sand and gravel is in the glacial outwash, but it contains a large percentage of shale particles derived from the Devonian bedrock and is of poor quality for use as concrete aggregate.

Mineral Industry Operations

Storage of Natural Gas

Iroquois Gas Company operates a gas storage field which would be partially inundated by the Zoar Valley Reservoir. This Zoar Field (fig. 4 - 25) which serves the Buffalo, N. Y., area contains 32 active wells, 20 which are below 1,200 feet, 17 below 1,150 feet, and 14 below 1,130 feet above sea level. The gas storage reservoir is the "Flint" (Onondaga) of Devonian age.

A pumping station (fig. 4 - 25) operated by Iroquois Gas Company supplies pressure for the Zoar Field and two other gas storage fields which are outside the proposed water development project area.

Transmission of Natural Gas and Petroleum

A system of pipelines transfers gas from the storage wells of the Zoar Field to the Iroquois Gas Company pumping station and to major trunk pipelines which carry gas to the points of use. The locations of gas pipelines operated by Iroquois Gas Company and Tennessee Gas Pipeline Company are shown on figure 4 - 25. Also shown is an oil products pipeline reportedly operated by National Transit Pipeline Company. Portions of these pipelines would be inundated by

a reservoir filled to an elevation of 1,200 feet, 1,150 feet, or 1,130 feet above sea level.

Mining of Sand and Gravel

Two inactive sand and gravel pits are shown inside the proposed reservoir on figure 4 - 25, south of Springville, N. Y. These pits are adjacent to Cattaraugus Creek at an elevation of about 1,150 feet above sea level. Sand and gravel appears to have been produced from a Recent stream terrace.

Just south of Springville, N. Y., (fig. 4 - 25) sand and gravel is produced from glacial outwash. The pit is located on a Pleistocene terrace about 2,000 feet from the proposed reservoir if the latter were filled to an elevation of 1,200 feet above sea level. The terrace elevation is about 1,350 feet above sea level at this pit.

Three inactive sand and gravel pits, south of Springville, N. Y., are shown outside the proposed reservoir on figure 4 - 25. Sand and gravel has been produced from Pleistocene outwash terrace deposits of each of these localities. Ground surface altitudes were about 1,350 feet above sea level prior to excavation of each pit.

Production of Premixed Concrete

Ashford Concrete Company operates a premixed concrete plant south of Springville, N. Y. (fig. 4 - 25). None of the raw materials used in the manufacture of the concrete, except water, is obtained from the area shown on figure 4 - 25. The plant supplies about nine concrete mixer trucks. Its facilities consist of a large shop building, an office building, tanks, bins, and hoppers for storing and dispensing water, cement, and aggregate.

Effect of Proposed Reservoir on Mineral Operations

Effect on Storage of Natural Gas

The proposed Zoar Valley Reservoir would affect Iroquois Gas Company's Zoar Field adversely. The Zoar Field contains 32 active gas storage wells, and the collars of 20 wells are below a 1,200 foot maximum pool elevation (fig. 4 - 25). Pool elevations of 1,150 feet and 1,130 feet would inundate 17 and 14 active wells, respectively. The wells subject to inundation could not be serviced when flooded. They probably would need to be plugged and abandoned so that there could be no exchange between surface water and subsurface fluids. The use of the remaining wells for gas storage may be feasible. Additional wells might be drilled outside the project area in the same or another exhausted gasfield to replace abandoned wells. If

drilling of replacement wells and/or operation of remaining wells is not possible, artificial storage might be supplied at higher cost by other methods.

Effect on Transmission of Natural Gas and Petroleum

Sections of pipelines which transport gas between Iroquois Gas Company's pumping station, trunk pipelines, and the Zoar Field wells would be under the proposed reservoir. These sections of pipe would need to be weighted and, possibly, replaced if operation of the Zoar Field is to be continued. A 4-inch diameter pipeline carries gas from the Zoar Field to Springville, N. Y. This line crosses the proposed reservoir and sections of it would need to be modified, or possibly, replaced for underwater service. If the Zoar Field were abandoned, a replacement line would be required to supply Springville with gas.

Two 8-inch, a 12-inch, and a 20-inch diameter trunklines owned by Iroquois Gas Company cross the proposed reservoir. A 24-inch diameter gas pipeline owned by Tennessee Gas Pipeline Company and a 6 (?)-inch diameter oil products pipeline, which is reportedly owned by National Transit Pipeline Company, also cross the proposed reservoir. Sections of each of these pipelines would require weighting and other modification for underwater service.

Effect on Mining of Sand and Gravel

No active sand and gravel operations would be flooded by the project. The effect on sand and gravel reserves would be negligible, as extensive deposits of similar quality occur outside the project area.

Effect on Production of Premixed Concrete

Ashford Concrete Company's plant is located outside the proposed reservoir area. However, it is within 200 feet (horizontally) of the maximum flood pool shoreline. Consequently, it might be desirable to relocate the plant.

Effect of Mineral Industries on the Reservoir Project

Any gas storage wells which are not plugged adequately may introduce pollutants to the surface water. The cost of acquiring the land in the Zoar Field will be increased by the value of the storage wells made unusable. Modification of the existing natural gas and petroleum pipelines also will add to the cost of the project.

The availability of sand and gravel in the reservoir area may facilitate construction activities. However, the local sand and gravel does not appear to be suitable for use as aggregate in high quality concrete.

The availability of a concrete mixing plant in the proposed reservoir area may benefit the project.

CONCLUSIONS

Replacement of gas storage capacity in the Zoar Field and modifications to natural gas and oil products pipelines would contribute significantly to the cost of the proposed reservoir project.

Natural storage to replace losses in the Zoar Field is expected to be available. Therefore, it is not likely that the higher cost of artificial storage will be encountered. If available natural storage is insufficient to replace all losses in the Zoar Field, artificial storage might be required for some quantity of gas. In this event, a study should be made to determine whether or not artificial storage could be provided by means of subsurface excavation at lower cost than tank storage.

The presence of sand and gravel deposits within the proposed reservoir area may affect the cost of land acquisition. However, the difference between value of land where sand and gravel occurs and where it does not occur probably will be insignificant.

If it becomes necessary to acquire or relocate the premixed concrete plant, the resulting cost would not be related to the acquisition of mineral rights.

More detailed study of the individual cost items should be conducted by the Corps of Engineers.

BIBLIOGRAPHY

1. Geological Society of America. Glacial Map of the United States East of the Rocky Mountains. 1959.

2. New York, The University of the State of. Geologic Map of New York. The State Education Dept., State Museum and Science Service, Geol. Survey, Niagara Sheet, 1961.

3. Oil and Gas Journal. Texas Eastern Unveils LNG Tank Plan, v. 63, September 13, 1965, pp. 64-65.

4. U.S. Department of the Interior. Topographic maps, Collins Center, N. Y. (1963), Ashford Hollow, N. Y. (1964), Langford, N. Y. (1960), Springville, N. Y. (1954), Sardinia, N. Y. (1957), and West Valley, N. Y. (1964) 7-1/2 Minute Quadrangles. Geological Survey.

MINERAL RESOURCES
IN
THE PROPOSED DUNKARD CREEK AND BIG SANDY CREEK RESERVOIR AREAS
MONONGAHELA RIVER BASIN, W. VA. AND PA.

by

Lawrence Y. Marks[1/]

An office review was made of published data and Bureau records. No field examination was made. Two proposed reservoir sites are included in this report because they are near each other and in similar mineral environments.

PROPOSED WATER DEVELOPMENT PROJECTS[2/]

The Dunkard Creek Dam would be near Poland Mines, Pa. At a pool elevation of 920 feet, the reservoir would cover 2,376 acres. It would be in Greene County, Pa.

The Big Sandy Creek Dam would be about 1 mile downstream from Clifton Mills, W. Va. The reservoir would cover 7,700 acres at a pool elevation of 1,700 feet. It would be in Preston County, W. Va., and Fayette County, Pa.

MINERAL RESOURCES

Coal, natural gas, and stone have been produced in the counties where these proposed projects would be constructed (1, 4, 8)[3/].

The proposed Dunkard Creek Reservoir would cover coalbeds of Pennsylvanian and Permian age (3, 6). Topographic maps indicate that extensive strip and deep coal mining has been done in and around the project area. Natural gasfields and oilfields occur in the area which would be affected (2, 7).

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2/ Data from Pittsburgh District Engineer, U.S. Army Corps of Engineers.
3/ Underlined numbers in parentheses refer to items in the list of references at the end of this report.

The proposed Big Sandy Creek Reservoir would inundate coal-bearing strata of Pennsylvanian age (3, 5-6). Minable coal may occur in the area.

Commercial stone and clay deposits might be affected by the reservoir projects.

CONCLUSIONS

Major conflicts probably would develop between the proposed Dunkard Creek project and bituminous coal and natural gas and petroleum activities. The acquisition of coal, oil, and gas, or provision for these minerals to be produced in the affected area, might increase the project cost substantially. The cost of locating and plugging abandoned oil and gas wells might add further to project cost. Any wells not plugged adequately might allow the exchange of fluids between the surface and subsurface.

At the proposed Big Sandy Creek project, only the acquisition of bituminous coal is expected to add significantly to project cost.

Stone and clay resources are not likely to conflict seriously because large reserves of similar material probably occur nearby, but outside the area which would be affected by either project.

Acid drainage derived from coal workings and outcrops might enter the proposed project reservoirs unless preventive measures have been taken.

Further study is recommended for each area to evaluate the extent of mineral involvements quantitatively. Field examinations should be made at each proposed project area.

REFERENCES

1. Ackerman, M. J. The Mineral Industry of West Virginia. Ch. in BuMines Minerals Yearbook, 1965, v. 3, 1967, pp. 871-888.

2. Lytle, W. S., and L. Heeren. Maps of the Oil and Gas Fields, Natural Gas Pipelines, and Oil Pipelines of Pennsylvania. Pennsylvania Dept. of Internal Affairs, Bur. of Topographic and Geol. Survey, Map No. 3, 1964.

3. Pennsylvania Topographic and Geologic Survey. Geologic Map of Pennsylvania. Dept. of Internal Affairs, 1960.

4. West Virginia Department of Mines. Annual Report. 1966, 256 pp.

5. West Virginia Geological and Economic Survey. Geologic Map of West Virginia. 1932.

6. _____. Mineral Resources and Mineral Industries of West Virginia. 1958, map.

7. _____. Map of Oil and Gas Fields of West Virginia. 1962.

8. Yeloushan, C. C. The Mineral Industry of Pennsylvania. Ch. in BuMines Minerals Yearbook, 1965, v. 3, 1967, pp. 679-709.

MINERAL RESOURCES
IN
THE PROPOSED LITTLE CONNOQUENESSING CREEK AND
GLADE RUN RESERVOIR AREAS, BEAVER RIVER BASIN, PA.

by

Lawrence Y. Marks[1]

An office review was made of published data and Bureau records. No field examination was made. Two proposed reservoir sites are included in this report because they are near each other and in similar mineral environments.

PROPOSED WATER DEVELOPMENT PROJECTS (4)[2]

The Little Connoquenessing Creek Dam would be 4.9 miles upstream from the mouth of Little Connoquenessing Creek in Butler County, Pa. It would control a drainage area of 48 square miles and, at a pool elevation of 1,100 feet, the reservoir would cover 3,039 acres.

The Glade Run Dam would be 0.6 mile upstream from the mouth of Glade Run in Butler County, Pa. It would control 41 square miles of drainage area and the reservoir would cover 3,892 acres at a pool elevation of 1,100 feet.

Both reservoirs would be entirely in Butler County, Pa.

MINERAL RESOURCES

Coal, natural gas, petroleum, cement, stone, lime, sand, and gravel were produced in Butler County, Pa., in 1965 (5). Coal-bearing rocks of Pennsylvanian age crop out in both proposed reservoir areas (3). Natural gasfields and petroleum fields occur in the vicinity of each proposed project (1). Many fields are no longer active, but depleted gasfields may be valuable for storage of gas produced elsewhere. The Vanport Limestone (Pennsylvanian age)

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2/ Underlined numbers in parentheses refer to items in the list of references at the end of this report.

underlies both proposed sites (2) and contains potential limestone reserves. Some of the sand and gravel in stream deposits (Recent) may be minable. Clay associated with coalbeds may be of commercial importance locally. Sandstone beds (Pennsylvanian) exposed at the surface may be suitable for building stone.

CONCLUSIONS

The proposed Little Connoquenessing Creek and Glade Run Reservoir areas contain coal, natural gas, petroleum, limestone, sand and gravel, and clay. Of these, coal, natural gas, and petroleum are most likely to conflict with the projects. Some depleted gasfields may be suitable for gas storage. Storage space may be in demand because of gas-consuming population centers nearby. Acquiring mineral ownership or providing for minerals to be extracted from the areas affected by these proposed projects is expected to increase project costs considerably.

Drainage derived from active and inactive coal mines and coal outcrops probably would contribute acid-forming materials to the reservoirs unless preventive measures have been taken. Fluids from oil and gas wells in the proposed reservoir areas might pollute the surface water unless each well has been plugged or sealed adequately. Locating and plugging abandoned wells would increase project costs.

It is recommended that the mineral resources be studied in greater detail, including a field examination of the sites. It then would be possible to estimate the magnitude of conflict between the projects and mineral resources and activities.

REFERENCES

1. Lytle, W. S., and L. Heeren. Maps of the Oil and Gas Fields, Natural Gas Pipelines, and Oil Pipelines of Pennsylvania. Pennsylvania Dept. of Internal Affairs, Bur. of Topographic and Geol. Survey, Map No. 3, 1964.

2. O'Neill, B. J., Jr. Atlas of Pennsylvania's Mineral Resources, Part I. Limestones and Dolomites of Pennsylvania. Pennsylvania Dept. of Internal Affairs, Bur. of Topographic and Geol. Survey, Mineral Resource Rept. M50, 1964, 40 pp.

3. Pennsylvania Topographic and Geologic Survey. Geologic Map of Pennsylvania. Department of Internal Affairs, 1960.

4. U.S. Army Corps of Engineers. Initial Investigations, Pittsburgh Engineer District, for Development of Water Resources in Appalachia. 1966.

5. Yeloushan, C. C. The Mineral Industry of Pennsylvania. Ch. in BuMines Minerals Yearbook, 1965, v. 3, 1967, pp. 679-709.

MINERAL RESOURCES
IN
THE PROPOSED LITTLE SANDY CREEK RESERVOIR AND NORTH FORK
REDBANK CREEK RESERVOIR AREAS, ALLEGHENY RIVER BASIN, PA.

by

C. Gordon Leaf[1/]

PROPOSED WATER DEVELOPMENT PROJECT

The proposed project includes two dams on streams tributary to Redbank Creek in Armstrong and Jefferson Counties, Pa. Because of the preliminary nature of the study, the type of structures and their specific purposes have not yet been designated. However, additional storage capacity is needed above Redbank Creek, particularly for flood control.

Little Sandy Creek Dam would control a drainage area of 68 square miles and would have a storage capacity of 111,000 acre feet at full pool elevation of 1,240 feet.

North Fork Redbank Creek Dam would control a drainage area of 82 square miles with a storage capacity of 108,000 acre feet at full pool elevation of 1,400 feet.

The investigation consisted of an office review of available literature on the area. No field work was performed. Because of the close proximity of the two sites in the Redbank Creek project, they are covered in one report. Both sites are in the Brookville, Pa., quadrangle (1)[2/] and are covered in the areal and mineral description of the quadrangle.

LOCATION

The Little Sandy Creek damsite would be on Little Sandy Creek, 0.25 mile above its junction with Redbank Creek in Armstrong County, Pa. The reservoir would lie mainly within Jefferson County, Pa.

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2/ Underlined numbers in parentheses refer to items in the list of references at the end of this report.

The North Fork damsite would be on the North Fork of Redbank Creek, 1.7 miles above its junction with Redbank Creek at Brookville, Pa. The reservoir would lie entirely within Jefferson County.

MINERAL RESOURCES

The principal mineral resources in the Brookville quadrangle are coal and natural gas, with clay, shale, limestone, and sandstone also occurring throughout the area.

Coal has been mined, since 1832, from seven horizons, the Upper and Lower Freeport, the Middle and Lower Kittanning, Clarion, Brookville, and Mercer (1). In 1965, 36 strip mines, 22 underground mines, and five auger mines were active in Jefferson County (3); mining was primarily in the Lower Freeport and the Lower and Middle Kittanning seams. A number of these mines are in the Brookville quadrangle. Many inactive and abandoned mines are also within the area. Coal reserves that would be flooded in the North Fork and Little Sandy Creek areas would be confined to the Mercer and Brookville seams, although access to mines and reserves in the higher coal seams might be lost.

Acid mine drainage does not appear to be a problem in either the North Fork or the Little Sandy areas. Acidity determinations taken by the Federal Water Pollution Control Administration ranged from pH 7.3 to pH 7.6 (2). The Pennsylvania State Planning Board reports acid pollution in tributaries to the Little Sandy Creek upstream of the proposed site.

The Brookville quadrangle has been one of the leading gas-producing areas in western Pennsylvania. The proposed reservoirs are within two active gasfields. These fields are considered shallow gas producers (above the Devonian Oriskany Formation). Two shallow gas storage fields are also in the region but would be outside the areas of impoundment.[3/]

Clay and shale resources consist of underclay found under all coalbeds in the area, flint clay found in the Mercer horizon around Brookville, and shale that makes up a large percentage of the Allegheny strata throughout the quadrangle. Some of these are suitable for the manufacture of common, face, and firebrick, hollow tile, sewer pipe, and pottery (1, p. 103), but only one plant is currently manufacturing clay products. Hanley Co. mines plastic fire clay from the Lower Kittanning and Lower Clarion horizons near Summerville, Pa., for the manufacture of building brick. This mine would be outside the area to be flooded by the proposed reservoirs.

3/ Verbal communication from William Lytle, Commonwealth of Pennsylvania, Department of Internal Affairs, Bureau of Topographic and Geologic Survey, Pittsburgh, Pa.

Limestone is present in several horizons, but the beds are thin and no operations are currently active.

The area around Brookville contains sandstone suitable for rough masonry, but no operations are known to be active.

CONCLUSIONS

Coal reserves and gas wells (both active and abandoned) may be affected by the proposed North Fork and Little Sandy Creek projects. A detailed study should be made to determine whether coal in the Mercer and Brookville seams is minable in the area. Access roads to some mines above the proposed reservoirs cross the reservoir areas and would have to be relocated. Alternately, compensation could be provided for coal remaining in these mines if access were cut off. Inactive gas wells should be located to determine whether they are adequately plugged. Active wells would have to be raised above the reservoir level or the owners compensated for their loss.

REFERENCES

1. Graeber, C. K., and R. M. Foose. Brookville Quadrangle, Pa. Topographic and Geol., Atlas 54, 1942, p. 79.

2. U.S. Army, Corps of Engineers. Initial Investigations Pittsburgh Engineer District for Development of Water Resources in Appalachia, 1966.

3. Yeloushan, Charles C. The Mineral Industry of Pennsylvania. Bureau of Mines Minerals Yearbook 1965, v. III, pub. 1967, p. 702.

MINERAL RESOURCES
IN
THE PROPOSED TEN MILE CREEK AND ELK CREEK RESERVOIR AREAS
MONONGAHELA RIVER BASIN, W. VA.

by

Lawrence Y. Marks[1/]

An office review was made of published data and Bureau records. No field examination was made. Two proposed reservoir sites are included in this report because they are near each other and in similar mineral environments.

PROPOSED WATER DEVELOPMENT PROJECTS (1)[2/]

The Ten Mile Creek Dam would be 2.2 miles downstream from Sardis, W. Va. It would control a drainage area of 58 square miles, and at a pool elevation of 1,000 feet the reservoir would cover 1,410 acres.

The Elk Creek Dam would be 0.4 mile upstream from Quiet Dell, W. Va. It would control 84 square miles of drainage area, and the reservoir would cover 3,348 acres at a pool elevation of 1,060 feet.

Both reservoirs would be entirely in Harrison County, W. Va.

MINERAL RESOURCES

Coal, natural gas, and stone were produced in Harrison County, W. Va., in 1966 (2). Coalbeds, shale, and sandstone of the Pennsylvanian System are exposed in both proposed reservoir areas (3). Bituminous coal has been mined in the vicinity of each proposed project, particularly Ten Mile Creek where large coal mines operate nearby (2, 4). Natural gasfields occur in both areas and

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2/ Underlined numbers in parentheses refer to items in the list of references at the end of this report.

oilfields in the Ten Mile Creek area (5). Some sandstone and shale beds might be suitable for use as construction raw materials, but their exploitation is dependent upon the development or existence of nearby markets. Rock salt probably underlies both areas (4), but its economic importance is doubtful.

CONCLUSIONS

The proposed Ten Mile Creek project is expected to conflict with active and inactive coal, natural gas, and oil operations. Acquisition of mineral rights or provision for mineral exploitation to continue in the affected areas might add considerably to project cost. Compensation to mineral owners for loss of stone, clay, and salt resources is likely to be nominal.

The proposed Elk Creek project is expected to conflict with natural gas and coal activities, and compensation for damages might be significant. Mineral rights for stone, clay, and salt probably could be acquired at moderate cost.

Acid water derived from coal workings and outcrops drains into Elk Creek and would pollute the proposed reservoir unless preventative measures have been taken. Abandoned and inadequately plugged oil and gas wells might allow the exchange of surface and subsurface fluids.

Mineral resources of both reservoir sites should be studied further and field examinations made of the areas which would be affected by the proposed projects.

REFERENCES

1. U.S. Army Corps of Engineers. Initial Investigations, Pittsburgh Engineer District, for Development of Water Resources in Appalachia. 1966.

2. West Virginia Department of Mines. Annual Report. 1966, 256 pp.

3. West Virginia Geological and Economic Survey. Geologic Map of West Virginia. 1932.

4. _____. Mineral Resources and Mineral Industries of West Virginia. 1958, map.

5. _____. Map of Oil and Gas Fields of West Virginia. 1962.

MINERAL RESOURCES
IN
THE PROPOSED TUBMILL CREEK RESERVOIR AREA
ALLEGHENY RIVER BASIN, PA.

by

Lawrence Y. Marks[1/]

An office review was made of published data and Bureau records. No field examination was made.

PROPOSED WATER DEVELOPMENT PROJECT (5)[2/]

The Tubmill Creek Dam would be 1.5 miles upstream from the mouth of Tubmill Creek. It would control a drainage area of 48 square miles, and at a pool elevation of 1,200 feet the reservoir would cover 2,310 acres in Westmoreland County, Pa.

MINERAL RESOURCES

Coal, sand and gravel, stone, and lime were produced in 1965 from Westmoreland County, Pa. (4). Pennsylvanian rocks containing coalbeds are exposed in the proposed reservoir area (3). A natural gasfield is about 4 miles east (1), and a limestone quarry is about 5 miles west (2). Some of the coalbeds that would be affected by the project may be minable. Fire clay associated with coal-bearing strata may be of commercial importance.

Acid drainage derived from coal workings and outcrops might enter the proposed reservoir unless abatement measures were taken.

CONCLUSIONS

Bituminous coal reserves might conflict with the proposed project. Acquisition of coal or provision for it to be mined in

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2/ Underlined numbers in parentheses refer to items in the list of references at the end of this report.

the affected area might add to the project cost. Natural gas and clay are expected to conflict less seriously with the project.

Acid drainage derived from coal workings and outcrops might enter the proposed reservoir unless abatement measures were taken.

The proposed site area should be studied in greater detail, including field examination, to determine the extent of mineral involvements.

REFERENCES

1. Lytle, W. S., and L. Heeren. Maps of the Oil and Gas Fields, Natural Gas Pipelines, and Oil Pipelines of Pennsylvania. Pennsylvania Dept. of Internal Affairs, Bur. of Topographic and Geol. Survey, Map No. 3, 1964.

2. O'Neill, B. J., Jr. Atlas of Pennsylvania's Mineral Resources. Part I. Limestones and Dolomites of Pennsylvania. Pennsylvania Dept. of Internal Affairs, Bur. of Topographic and Geol. Survey, Mineral Resource Rept. M50, 1964, 40 pp.

3. Pennsylvania Topographic and Geologic Survey. Geologic Map of Pennsylvania. Dept. of Internal Affairs, 1960.

4. U.S. Army Corps of Engineers. Initial Investigations, Pittsburgh Engineer District, for Development of Water Resources in Appalachia. 1966.

5. Yeloushan, C. C. The Mineral Industry of Pennsylvania. BuMines Minerals Yearbook 1965, v. 3, 1967, pp. 679-709.

SUBREGION G

MINERAL RESOURCES
IN
THE PROPOSED ROYALTON-SALYERSVILLE RESERVOIR AREA
LICKING RIVER BASIN, KY.

by

F. Vernon Tompkins[1/]

ABSTRACT

The Royalton-Salyersville water development, an Appalachian Region project proposed by the U.S. Army Corps of Engineers, includes a dam, reservoir, and channel improvement on the Licking River in southern Magoffin County, Ky. A study of the mineral resources of the area by the Federal Bureau of Mines was limited to coal. Water development and mining are in conflict at two locations but data were not available to evaluate the coal in one area. A major conflict is the coal reserves of the Princess Elkhorn No. 1 mine. This underground operation, which enters the Upper Elkhorn No. 1 coalbed at David, Ky., has progressed until current mining is beneath the proposed reservoir.

PROPOSED WATER DEVELOPMENT PROJECT

The Royalton-Salyersville water development project of the U.S. Army Corps of Engineers is on the Licking River in east-central Kentucky, and includes channel improvement, a dam, and reservoir for floodwater control, water quality control, water supply, and recreation. The purpose of the project is the economic development of Magoffin County and vicinity by attracting light industry to flood-free locations in the limited valley area between Royalton and Salyersville, Ky. The project is proposed under the Appalachian Regional Development Act of 1965.

Plans for water development call for a rock and earthfill dam approximately 1/4 mile upstream from Royalton with a length of about 1,000 feet and a maximum height of 116 feet, and 8 miles of channel improvement starting 2 miles upstream from Salyersville and extending downstream. The drainage basin above the damsite has an area of 76 square miles. The reservoir would have a total capacity of 64,500 acre-feet, including 4,000

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acre-feet for water quality control and 49,000 acre-feet for floodwater control. The flood pool would have an elevation of 958 feet and an area of 2,280 acres.

Mineral investigation by the Bureau of Mines concerned the coal resources of the reservoir area. Information was obtained by library research and from interviews with personnel of coal companies, the Kentucky Department of Mines and Minerals, and the Federal Geological Survey in Lexington, Ky. A report by a consultant was reviewed, and generalizations concerning oil and gas are from this source.

LOCATION

The proposed Royalton-Salyersville project would be in the southern half of Magoffin County, Ky., on the upper part of the Licking River, a stream of the Ohio River Drainage Basin (fig. 4 - 26).

TOPOGRAPHY AND GEOLOGY

Southern Magoffin County is near the southwestern edge of the Allegheny Plateau physiographic province in an area where erosion of nearly flat sediments has resulted in a dendritic drainage pattern. The maturity of the topography is characterized by narrow flood plain valleys along the larger streams and rolling to moderately steep upland hills.

The rocks of the Licking River Basin above Royalton, stratified sandstone, shale, and coal, are part of the Breathitt Formation of Pennsylvanian age. They lie in the Eastern Kentucky Syncline, a broad regional structural basin with a length of over 100 miles and a general northeasterly trace. In the Licking River Basin the axis of the syncline strikes east and plunges westward at less than 10 feet per mile. The dip of the beds on the northern side of this structure is about 30 feet per mile to the south and on the southern side is about 20 feet per mile to the north.

MINERAL RESOURCES

A minimum of 18 coal horizons occur in the Pennsylvanian Breathitt Formation within the Basin. Some are laterally discontinuous; others, while continuous, are too thin to be economical; and others, with continuity, are lenticular, and locally have coal of economic thickness and quality. A few have thickness, continuity, and quality to support large continuous operations.

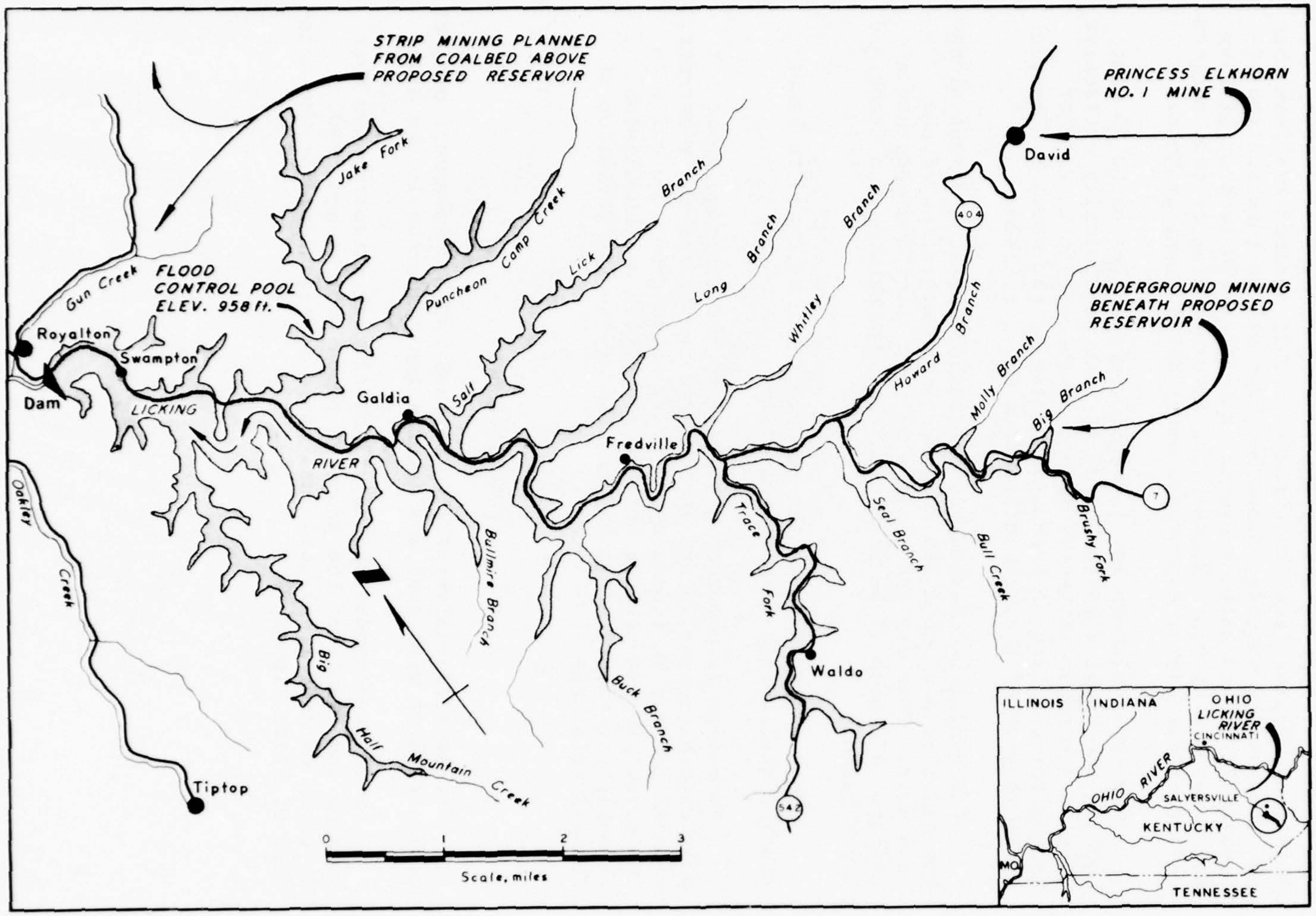

FIGURE 4 - 26. - Areas of Mining and Coal Resources of the Proposed Royalton Reservoir on the Licking River, Magoffin County, Ky.

The Upper Elkhorn No. 3 coalbed supports large mining operations. It crops out in the Big Sandy watershed to the east and underlies most or all of the Licking River Basin above Royalton. Depths from the surface of this coalbed are less than 100 feet at the damsite, about 300 feet at the intersection of Licking River and Whitley Branch, and about 250 feet at Licking River and Big Branch. Present and future mining of this coalbed will conflict with the proposed water development project.

The Upper Elkhorn No. 1 coalbed, which lies 65 to 85 feet beneath the Upper Elkhorn No. 3, is less economically attractive because a minable thickness is not always present. Primary reason for the lack of extensive mining in the No. 1 bed is the large reserve of the more attractive No. 3 coalbed.

The Haddix and Hazard No. 5A coalbeds which crop out along the hillside are about 200 feet above the elevation of the reservoir. They are about 15 to 60 feet apart and each has a maximum thickness of 48 inches in the area between Gun Creek and Long Branch.

Other coalbeds above the reservoir are expected to be of minable quality and thickness locally.

Petroleum is produced elsewhere in the drainage basin but only natural gas wells are in the area needed for the reservoir. Natural gas may be found in any of 12 known producing units in the stratigraphic section between the bottom of the Clinton Formation of Silurian age and the top of the Lee Formation of Pennsylvanian age.

CONCLUSIONS

The Royalton-Salyersville proposed water development project would conflict with coal and natural gas resources in the area.

It is recommended that a pillar of coal extending 200 feet outside the limits of the proposed flood pool be acquired. Purchase of additional coal land would be necessary for the location of State Highway 7.

MINERAL RESOURCES
IN
THE PROPOSED LAUREL CREEK AND TETER CREEK RESERVOIR AREAS
MONONGAHELA RIVER BASIN, W. VA.

by

Lawrence Y. Marks[1/]

An office review was made of published data and Bureau records. No field examination was made. Two proposed reservoir sites are included in this report because they are near each other and in similar mineral environments.

PROPOSED WATER DEVELOPMENT PROJECTS (1)[2/]

The Laurel Creek Dam would be 0.3 mile upstream from the mouth of Laurel Creek. It would control a drainage area of 47 square miles, and at a pool elevation of 1,600 feet the reservoir would cover 1,740 acres.

The Teter Creek Dam would be 0.5 mile upstream from Moatsville, W. Va. It would control 45 square miles of drainage area, and the reservoir would cover 2,535 acres at a pool elevation of 1,500 feet.

Both reservoirs would be in Barbour County, W. Va.

MINERAL RESOURCES

Coal and natural gas were produced in 1966 from Barbour County, W. Va. (2). Pennsylvanian strata containing coalbeds are exposed in both proposed reservoir areas (3) and minable coal probably occurs in each area (4). There is potential for natural gas and petroleum occurrence in both project areas; natural gas was produced in a field about 2 miles north of the proposed Teter Creek Dam (5).

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2/ Underlined numbers in parentheses refer to items in the list of references at the end of this report.

CONCLUSIONS

Bituminous coal is the mineral commodity most likely to conflict with the proposed Laurel Creek and Teter Creek Reservoirs. The project costs might be increased significantly by the acquisition of coal rights or provision for coal to be extracted from areas which would be affected by the reservoirs. Owners of natural gas and petroleum reserves might need to be compensated, particularly if recent discoveries of oil or gas have been made in or near the project areas.

Acid water derived from coal workings and outcrops might enter the proposed reservoirs unless abatement measures have been taken.

Mineral resources should be studied in greater detail so that the magnitude of conflicts between minerals and the proposed projects can be estimated. The studies should include field examinations of the sites.

REFERENCES

1. U.S. Army Corps of Engineers. Initial Investigations, Pittsburgh Engineer District, for Development of Water Resources in Appalachia. 1966.

2. West Virginia Department of Mines. Annual Report. 1966, 256 pp.

3. West Virginia Geological and Economic Survey. Geologic Map of West Virginia. 1932.

4. _____. Mineral Resources and Mineral Industries of West Virginia. 1958, map.

5. _____. Map of Oil and Gas Fields of West Virginia. 1962.

MINERAL RESOURCES
IN
THE PROPOSED MIDDLE FORK RIVER AND BUCKHANNON RIVER
RESERVOIR AREAS, MONONGAHELA RIVER BASIN, W. VA.

by

Lawrence Y. Marks[1/]

An office review was made of published data and Bureau records. No field examination was made. Two proposed reservoir sites are included in this report because they are near each other and in similar mineral environments.

PROPOSED WATER DEVELOPMENT PROJECTS (1)[2/]

The Middle Fork River Dam would be about 2,000 feet downstream from the mouth of Hanging Run. It would control a drainage area of 31 square miles, and at a pool elevation of 1,960 feet the reservoir would cover 5,550 acres in Upshur, Barbour, and Randolph Counties, W. Va.

The Buckhannon River Dam would be just downstream from Hampton, W. Va. It would control 41 square miles of drainage area, and the reservoir would cover 5,200 acres in Upshur County at a pool elevation of 1,500 feet.

MINERAL RESOURCES

Coal and natural gas were produced in Barbour, Randolph, and Upshur Counties, and stone in Barbour and Randolph Counties in 1966 (2). Pennsylvanian rocks containing minable coalbeds crop out in the areas which would be flooded by each proposed project (3-4). Natural gasfields occur in part of the area which would be inundated by each project (5). Clay is of commercial importance in some Pennsylvanian strata, and has been produced about 4 miles northeast of the proposed Buckhannon River Dam (4).

1/ Geologist, Pittsburgh Office of Mineral Resources, Bureau of Mines, U.S. Department of the Interior, Pittsburgh, Pa.
2/ Underlined numbers in parentheses refer to items in the list of references at the end of this report.

CONCLUSIONS

Coal and natural gas are likely to conflict with both the proposed Middle Fork River and Buckhannon River projects. Significant project costs might be incurred to acquire mineral ownership or provide for mineral operations to continue in areas affected by the proposed reservoirs. Compensation for loss of clay and stone reserves is expected to add little to the cost of these projects.

Acid drainage derived from coal workings and outcrops might enter either proposed reservoir unless abatement measures have been taken. Abandoned wells not plugged adequately might permit exchange of fluids between the surface and subsurface.

Mineral resources should be studied in greater detail so that the conflicts between minerals and the proposed projects can be estimated quantitatively. The studies should include field examinations of each site.

REFERENCES

1. U.S. Army Corps of Engineers. Initial Investigations, Pittsburgh Engineer District, for Development of Water Resources in Appalachia. 1966.

2. West Virginia Department of Mines. Annual Report. 1966, 256 pp.

3. West Virginia Geological and Economic Survey. Geologic Map of West Virginia. 1932.

4. _____. Mineral Resources and Mineral Industries of West Virginia. 1958, map.

5. _____. Map of Oil and Gas Fields of West Virginia. 1962.

MINERAL RESOURCES
IN
THE PROPOSED UPPER TYGART VALLEY RIVER RESERVOIR AREA
MONONGAHELA RIVER BASIN, W. VA.

by

Lawrence Y. Marks1/

An office review was made of published data and Bureau records. No field examination was made.

PROPOSED WATER DEVELOPMENT PROJECT (1)2/

The Upper Tygart Valley River Dam would be 1.5 miles upstream from Lee Bell, W. Va. It would control a drainage area of 84 square miles, and the reservoir would cover 1,760 acres in Randolph County, W. Va., at a pool elevation of 2,300 feet.

MINERAL RESOURCES

Sandstone was produced in Randolph County, W. Va., in 1966 (2). Shale and fine-grained sandstone of the Portage and Chemung Formations of Devonian age are exposed in much of the proposed reservoir area; some coarse sandstone of the Pocono Formation (Mississippian) also may be inundated (3). Flagstone occurs in the Portage and Chemung Formations; dimension sandstone blocks have been quarried from the Pocono Formation.

CONCLUSIONS

Some minable stone might be inundated by the proposed Upper Tygart Valley River Reservoir, but abundant stone reserves of similar quality occur nearby, outside the affected area. Compensation to owners for conflicts with mining activities is expected to be negligible.

1/ Geologist, Pittsburgh Office of Mineral Resources, Bureau of Mines, U.S. Department of the Interior, Pittsburgh, Pa.

2/ Underlined numbers in parentheses refer to items in the list of references at the end of this report.

A more detailed mineral resources study, including a field examination, should be made of the proposed project area.

REFERENCES

1. U.S. Army Corps of Engineers. Initial Investigations, Pittsburgh Engineer District, for Development of Water Resources in Appalachia. 1966.

2. West Virginia Department of Mines. Annual Report. 1966, 256 pp.

3. West Virginia Geological and Economic Survey. Geologic Map of West Virginia. 1932.

SUBREGION H

MINERAL RESOURCES
IN
THE PROPOSED ULVAH (KINGDOM COME) RESERVOIR AREA
KENTUCKY RIVER BASIN, KY.

by

James R. Boyle[1/]

ABSTRACT

An onsite examination was made by the Bureau of Mines in the proposed Ulvah (Kingdom Come) Reservoir area, Letcher County, Ky., to determine mineral resources which would be affected. Coal production from the area is approximately a million tons per year. An estimated 9,000 acres of recoverable coal with an average thickness of 41 inches would be affected. An evaluation of these reserves was made based on an estimated value of $150 per acre. The value of this coal was estimated to be nearly $1.35 million.

A benefit of the proposed reservoir could be the relocation of the Louisville & Nashville Railroad down Line Fork. With this relocation, one coal company official estimated production from the Line Fork area would double that from the proposed reservoir area.

PROPOSED WATER DEVELOPMENT PROJECT

The proposed water development project is on the North Fork of Kentucky River in Letcher County, Ky. It is proposed that an earth-type dam be constructed at stream mile 127 with a drainage area of 198 square miles. Major benefits include flood control for downstream areas, water quality, water supply, and recreation.

The Bureau of Mines conducted an investigation to determine the mineral resources that would be affected in the proposed reservoir. This investigation was limited to the area encompassed at full pool elevation plus a 300-foot strip of land measured horizontally, surrounding the proposed reservoir at full pool level, and other areas that would be affected by loss of access.

LOCATION

The proposed Ulvah (Kingdom Come) Reservoir would be in Letcher County, Ky.; the damsite would be approximately 12 miles west of

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Whitesburg, near Ulvah. Water would be backed up the North Fork of Kentucky River to the outskirts of Whitesburg, and up Rockhouse Creek to Sackett (fig. 4 - 27).

TOPOGRAPHY AND GEOLOGY

The proposed reservoir lies in a sharply dissected area of the Appalachian Plateau. The topography of the area is mountainous with deep V-shaped valleys separated by narrow sinuous ridges. Cliffs or benches of irregular continuity line the steep slopes at many places (1, p. 100).[2] Maximum relief is approximately 1,200 feet and flatland is for the most part limited to narrow flood plains along the North Fork of Kentucky River and Rockhouse Creek.

The outcropping bedrock of the area is the Breathitt Formation of Pennsylvanian age. It consists of beds of sandstone and shale interbedded with lesser quantities of coal, underclay, limestone, and chert. Six or more minable coalbeds occur in the proposed reservoir area. Structural features are very gentle and do not impede mining operations (1, pp. 102-105).

MINERAL RESOURCES

There are two coalbeds of major importance in Letcher County (3, p. 1), from the standpoint of present production: Upper Elkhorn No. 3, and Fire Clay (also called Hazard No. 4). Only the Fire Clay seam is of major importance in the proposed reservoir area.

The general area of the proposed reservoir is a major coal producing area and has been for many years.

Coalbeds that have been mined in the area, in addition to the Fire Clay, are the Whitesburg, Hazard No. 5A, Hazard No. 7, and the Amburgy. Thickness of the beds mined ranges from 26 to 60 inches. The coal is of high-volatile A bituminous rank and is generally low in moisture, ash, and sulfur. The coal has good coking and burning characteristics. Sulfur content is usually about 1 percent, with the exception of the Amburgy which is usually about 3 to 4 percent (2, pp. 351-356). With the exception of the Fire Clay, the beds tend to be erratic and contain slate partings and impurities. This results in limited areas where these beds are suitable for mining.

Known gasfields do not extend into the proposed reservoir area. Although there has been production north of the area, sufficient information does not exist to evaluate the potential in the proposed reservoir area.

2/ Underlined numbers in parentheses refer to items in the list of references at the end of this report.

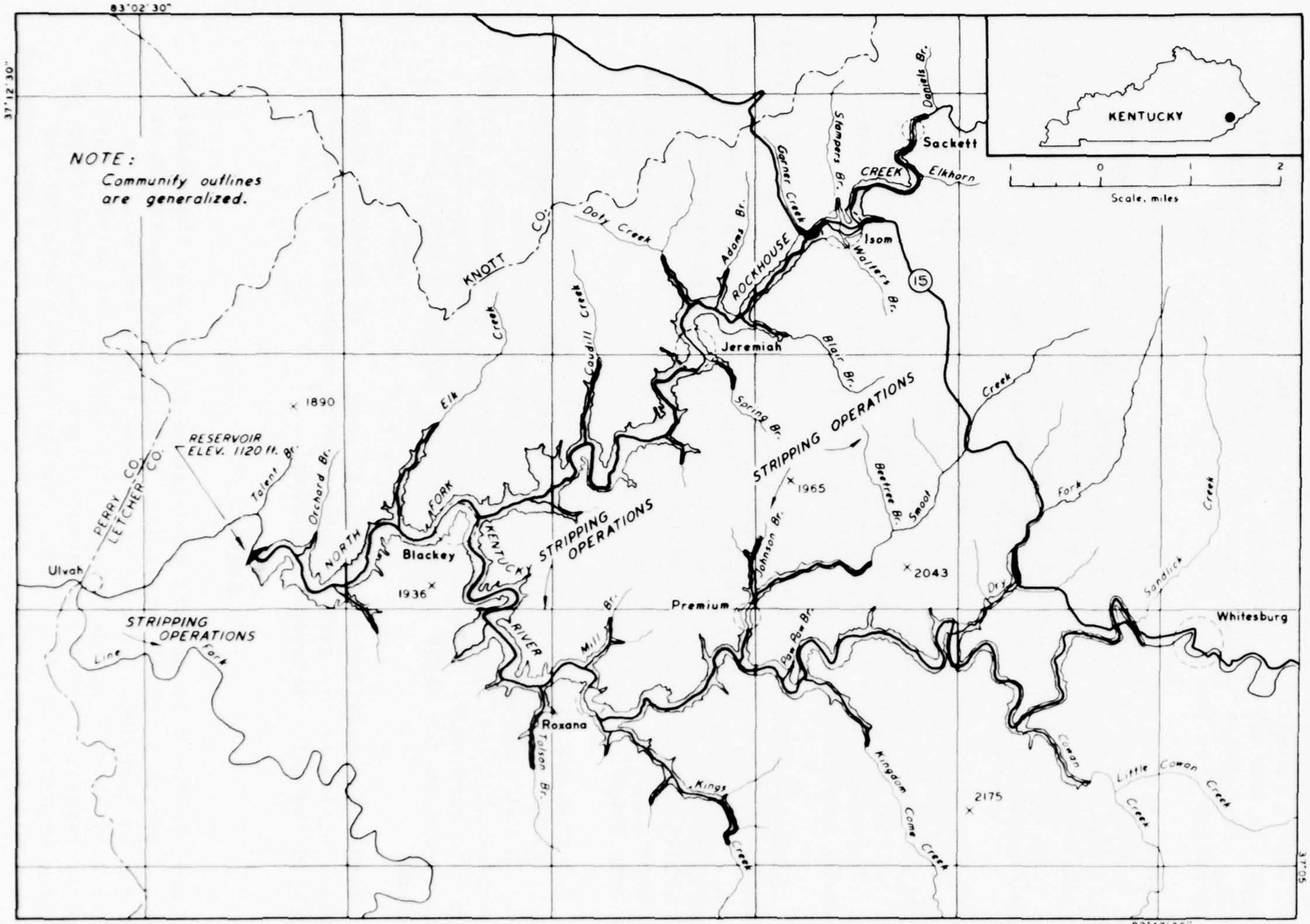

FIGURE 4 - 27. - Proposed Ulvah (Kingdom Come) Reservoir Area.

The Bureau of Mines has records of 154 coal mines in the area, 145 underground, six auger, and three strip. Sixty-two of the mines were considered active in 1965, of these 54 were underground, five auger, and three strip. Of the active mines, 44 mined the Fire Clay, 12 mined the Whitesburg, five mined the Hazard No. 7, and one the Amburgy. Production in 1965 from the area was about a million tons, predominantly from the Fire Clay seam.

Active mining operations are known to be in the vicinity of Adams Branch, Blair Branch, Caudill Creek, Daniels Branch, Garner Creek, Kings Creek, Mill Branch, Paw Paw Branch, Smoot Creek, Stampers Branch, and Tolson Branch. Inactive operations are in these same areas plus others in the Bee Tree Branch, Doty Creek, Elk Branch, Johnson Branch, and Trace Fork areas.

As far as can be determined, all mines are above full pool elevation of the proposed reservoir. Of the coalbeds being mined, the Amburgy would be the only one below pool elevation and then only near the damsite, but no minable reserves exist in this particular area. Most mines will be affected by loss of access, but in some instances other access routes could be developed.

Although the proposed Ulvah (Kingdom Come) Reservoir would curtail production considerably from the area, relocation of the Louisville and Nashville Railroad (L & N) along Line Fork would stimulate development of coalfields in this area. One company official, whose company has land holdings in both areas, estimated that production from the Line Fork area would be twice the production from the Ulvah (Kingdom Come) Reservoir area.

For southern markets, coal must travel over 100 miles north by rail to Winchester, Ky., before going south. With the relocation of the L & N Railroad down Line Fork, it is conceivable that a connection could be made to eliminate this long switchback. If this connection were made, it would probably result in increased coal production from the areas in East Kentucky served by the L & N Railroad.

Although a detailed study was not made, it is believed that previous mining in the area of the proposed reservoir will have no effect on the water-development project.

EVALUATION

Coal is the only mineral being mined in the area that would be affected by the proposed reservoir. No mines are expected to be lost due to flooding, but most coal mines in the area would be affected by loss of access because they are located between the proposed reservoir and the adjacent ridges. All the coal ramps in the area would be flooded. Mines that can develop other access routes would have to transport coal to coal ramps out of the affected area.

Nearly 17,000 acres of coal lands may be affected by the proposed reservoir. Of this acreage, nearly 6,000 acres have been mined, about 2,000 acres are believed to contain nonrecoverable coal, and about 9,000 acres contain recoverable coal. Kentucky River Coal Corp., and Virginia Iron Coal and Coke Co., own most of the coal lands in the area.

Coalbeds which are not being mined were excluded from consideration because of insufficient information in support of their minability.

No coal reserves are located inside a horizontal 300-foot boundary around the limits of full pool elevation of the proposed reservoir. The reserves affected are those located between the full pool elevation and the surrounding ridges. Because of the proposed reservoir, it was assumed that mining of this coal would be prohibited.

For evaluation purposes, the area was divided into seven subareas, using creeks and ridges as natural geographic boundaries. The areas were measured to determine acreage, and from available records of coal mines in the subareas, and other sources, coal thicknesses were estimated for each bed in each subarea. Coal thicknesses over the entire area averaged 41 inches. Coal reserves were then calculated, predominantly for the Fire Clay bed, but also including the Hazard No. 7, Whitesburg, and Amburgy beds. Estimates of past mining activity in each subarea were made. From these data, it was estimated that 38 percent of the minable coal acreage has been mined. It was also estimated that 50 percent of the remaining recoverable coal reserves could be mined. For evaluation purposes, an estimated value of $150 per acre was placed on acreage with recoverable coal; this is the equivalent of $0.05 per ton.

Results of the evaluation are as follows:

Total coal acreage affected...........	16,595
Inferior quality coal acreage..........	2,008
Minable coal acreage..................	14,587
Mined out acreage.....................	5,575
Remaining minable coal acreage.........	9,012
Tonnage remaining (1,800 tons coal per acre foot)......	55,379,000
Recoverable tonnage (50 percent recovery).........	27,689,000
Evaluation ($150 per acre).............	$1,352,000

The coal generally is of high-volatile A bituminous rank and has good coking and burning characteristics. In one subarea, reportedly poor roof conditions could affect recovery, but the reserves were included as recoverable because of insufficient information concerning these roof conditions.

Company officials estimated that 35 percent of the coal in the area has been mined compared to an estimate by this study of 38 percent. No estimate was made to determine how much of the remaining recoverable coal would actually be mined. Mining costs will increase as underground mines go deeper, and more economical mining of coal reserves in nearby areas could limit recovery of all reserves in the proposed reservoir area.

A recovery factor of 50 percent was used, although presently underground and strip mines do recover a larger percentage. However, the main portion of recoverable reserves would be developed by underground operations with more cover than present operations, and would probably result in a decrease of the present recovery rate.

The value of the remaining recoverable coal in the area is estimated to be $1.35 million, based on a figure of $150 per acre. Coal lands are sold on an acreage basis and recent sales of coal land indicate that $150 per acre is a reasonable figure for coal land in the area.

CONCLUSIONS

Coal reserves will be affected by the proposed reservoir. Of the total of approximately 17,000 acres of coal lands affected, about 9,000 acres contain recoverable coal averaging 41 inches in thickness. The balance of the acreage is either of inferior quality coal or has already been mined out.

A value of $1.35 million was placed on the remaining affected coal reserves, based on an estimated value of $150 per acre. No estimate was made of reserves that would actually be mined.

Relocation of the L & N Railroad down Line Fork would help to develop coal reserves in that area with an estimated increase of production over that of the affected area.

REFERENCES

1. Huddle, J. W., E. J. Lyons, H. L. Smith, and J. R. Ferm. Coal Reserves of Eastern Kentucky. U.S. Geol. Survey Bull. 1120, 1963, 247 pp.

2. Keystone Coal Buyers Manual. McGraw-Hill, Inc., New York, 1966, 648 pp.

3. Wallace, J. J., J. J. Dowd, R. G. Travis, R. F. Abernethy, and D. A. Reynolds. Estimate of Known Recoverable Reserves of Coking Coal in Letcher County, Ky. BuMines Rept. of Inv. 5016, 1953, 26 pp.

SUBREGION I

MINERAL RESOURCES
IN
THE PROPOSED CELINA RESERVOIR AREA
CUMBERLAND RIVER BASIN, KY.

by

Vernal A. Danielson[1/]

ABSTRACT

A literature survey and site inspection of the proposed Celina Reservoir site on the Cumberland River in Monroe, Cumberland, Russell, and Clinton Counties, Ky., in the Cumberland River Basin, revealed that the only known mineral resource affected would be petroleum. Eleven wells on three leases would be inundated to a depth of 2 to 10 feet. Access to the Goose Creek area, another important area of oil production in Cumberland County, would be affected also.

PROPOSED WATER DEVELOPMENT PROJECT

The proposed project consists of a navigation lock and dam on the Cumberland River, on the Kentucky-Tennessee boundary line. The purposes of the project include extension of navigation, electric power generation, and recreation.

The reservoir would extend 75.5 river-miles and include about 15,000 surface-acres. Drainage area controlled by the dam would be about 500 square miles.

LOCATION

The project area under consideration extends from Cumberland River mile 385.4 in Monroe County, Ky., and Clay County, Tenn., to Wolf Creek Dam at mile 460.9 in Russell County, Ky. Parts of Cumberland and Clinton Counties, Ky., are included. The proposed damsite is 5 miles north of Celina, Clay County, Tenn., in the Cumberland River Basin.

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TOPOGRAPHY AND GEOLOGY

The Celina project is in the northern part of the Eastern Highland Rim province, a gently sloping plain that lies between the Cumberland Plateau and the Nashville Basin. The area is generally underlain by flat-lying limestones, shales, and sandstones of Mississippian age.

In the Highland Rim province, numerous isolated hills and ridges rise into Pennsylvanian rocks along its border with the Cumberland Plateau. In areas bordering the larger streams and the irregular escarpment along the Nashville Basin, the rim has been dissected to narrow, steep ridges exposing the underlying Ordovician rocks. The elevation of the rim is 1,000 to 2,000 feet above mean sea level.

MINERAL RESOURCES

Description

Petroleum is the only mineral resource of economic importance in the proposed reservoir area. No other mineral resources were noted in either the literature or the field studies, except for some limestone and sandstone that might be utilized for construction purposes.

Active Oil Wells

All of the active wells are in Cumberland County, Ky. (fig. 4 - 28). There are probably a number of unplugged abandoned wells, the locations of which could not be determined without a more thorough survey.

Effect of Water Development Project on the Mineral Industry

The immediate effect of the water development project on the mineral industry in the reservoir area would be the inundation of several producing oil wells. Access to another important producing area would also be affected.

Effect of Mineral Resources and Mineral Industry on the Water Development Project

The effect the oil industry might have on the water development project is that of pollution of the reservoir. Water pollution associated with the production of crude oil is caused by waste oil dumped from tank batteries, waste oil bailed during drilling operations, and disposal of salt water. The waste oil can be

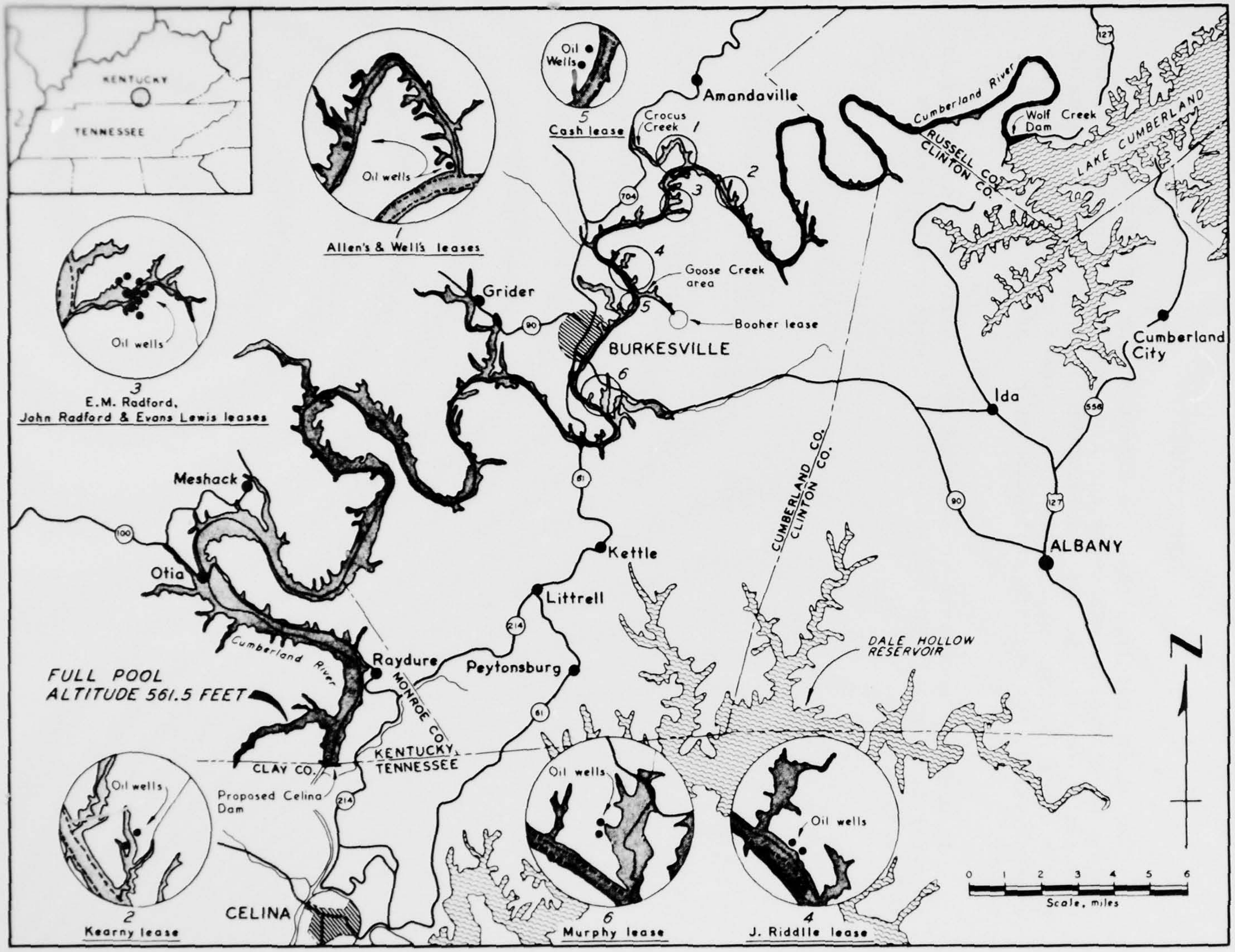

FIGURE 4 - 28. - Location of Oil Wells in Celina Reservoir Project.

disposed of by impounding in pits and burning, but it is more difficult to dispose of the salt water.

CONCLUSIONS

The study indicates that the effect of the Celina Reservoir project on mineral resources of the area would be comparatively minor. Only small areas of the oil leases would be inundated. The value of the land for farming purposes is in most cases much greater than its mineral value, but surface evaluation is beyond the scope of this report.

It would be necessary to relocate some sections of access roads in order to permit further development of the petroleum reserves in this area.

MINERAL RESOURCES
IN
THE PROPOSED DEVILS JUMPS RESERVOIR AREA
CUMBERLAND RIVER BASIN, KY.-TENN.

by

Robert C. Johnson 1/

ABSTRACT

The proposed Devils Jumps Reservoir project of the U.S. Army Corps of Engineers is in parts of McCreary County, Ky., and Scott, Pickett, Morgan, and Fentress Counties, Tenn. Coal is the only mineral resource in the area that would add significantly to the cost of the project. Four abandoned underground mines and nine abandoned strip mines are within the area that would be acquired for the reservoir. No evidence of current mining within this area was found, but active mines at higher elevations outside the reservoir area ship coal via the Tennessee Railroad Company and The Brimstone Railroad, whose tracks would be partially inundated by the proposed reservoir. Four abandoned oil wells are known; prospects for future oil discoveries could not be determined. Shale, underlying coalbeds and often called "fire clay", also occurs within the proposed reservoir area, but insufficient data were available to evaluate economic potential. At present both oil and shale are of minor importance and should not add significantly to the cost of land acquisition.

Two areas containing coal of minable thickness and continuity underlie 8,085 acres of land that would be acquired for the reservoir. If the project is approved and implemented, a detailed reappraisal should be made to determine mineral values for specific parcels of land. Water quality in the proposed reservoir should not be adversely affected by mining except locally.

PROPOSED WATER DEVELOPMENT PROJECT

The selected plan of improvement for the Big South Fork of the Cumberland River consists of the construction of a powerhouse and a rock-fill dam (Devils Jumps) at 47.9 and 48.1 miles, respectively, above the mouth. The dam would be 483 feet high with a top altitude of 1,233 feet. The maximum flood pool of the reservoir would

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be at an altitude of 1,220 feet and would cover 36,990 acres. An estimated 77,125 acres would be acquired for the project, including a strip of land 300 feet wide, measured horizontally, outside the maximum flood pool shoreline. The power installation would contain four generating units having a combined rating of 480 megawatts. Purposes of the project are flood control, power, and recreation.

The Bureau of Mines investigated the mineral resources that would be affected by the proposed reservoir. Discussions were held with the Tennessee Division of Geology, Stearns Coal and Lumber Company, Tennessee Railroad Company, and Brimstone Railroad, regarding mineral resources in the proposed reservoir area. A field examination of the area was made in May 1967.

LOCATION

The proposed Devils Jumps damsite would be in McCreary County, Ky., on the Big South Fork of the Cumberland River, about 3 miles north of the Tennessee State line. The reservoir would lie in parts of McCreary County, Ky., and Scott, Pickett, Morgan, and Fentress Counties, Tenn. The villages of New River, Newtown, Winona, Norma, Montgomery, Hughett, and Slick Rock, situated near the headwaters of the reservoir in Scott County, Tenn., would be wholly or partially inundated (fig. 4 - 29).

TOPOGRAPHY AND GEOLOGY

The proposed reservoir area is part of the Cumberland Plateau section of the Appalachian Plateaus province and is typified by broad rolling uplands 200 to 500 feet above the streambeds. The southeastern portion of the proposed reservoir area would lie in the Cumberland Mountains, a rugged area with local sharp relief ranging from 1,000 to 1,900 feet. Cliffs and benches along the slopes are not uncommon. Maximum altitude in the area is 3,534 feet. Total relief for the watershed, considering the streambed at damsite as the low point, is about 2,784 feet.

The valley bottoms in the lower half of the proposed reservoir area are underlain by Mississippian limestones and shales. Pennsylvanian sandstones, shales, and coalbeds overlie the Mississippian rocks and extend to the hilltops. The regional attitude of the beds is almost horizontal, but local irregularities exist. Cross-bedding accounts for many dips. No faults were observed, nor were any reported in the area.

MINERAL RESOURCES

Mineral resources that would be affected by the reservoir are coal and possibly oil, fire clay, and limestone.

Numerous coal seams in the reservoir area are typically irregular in thickness, of poor quality, and horizontally discontinuous. The thickest coalbeds that would be flooded by the reservoir are present in

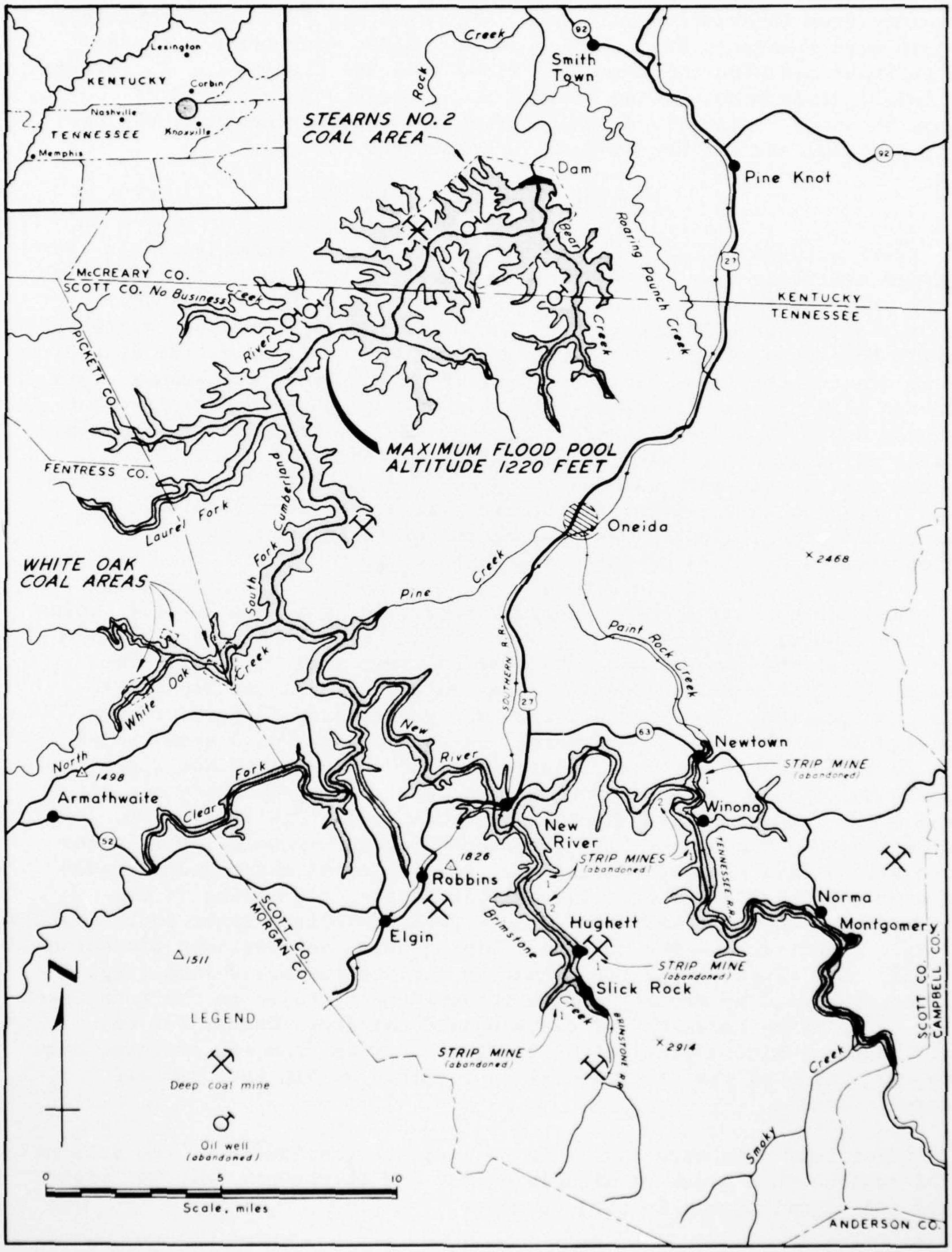

FIGURE 4 - 29. - Proposed Devils Jumps Reservoir Area.

the lowermost strata of Pennsylvanian age. Lateral correlation of coalbeds over great distances in this geologic horizon cannot be made with certainty from information available. The beds may pinch out completely or join with others to form thicker seams. Names most often used for the thickest coalbeds below maximum flood pool are Stearns No. 1, Stearns No. 1-1/2, Stearns No. 2, and Stearns No. 3 coals. Pomerene (3)[2/] groups the beds regionally as the Stearns Coal Zone in Kentucky and the White Oak Coal and the Wilder Coal in Tennessee.

Stearns No. 2 Coal Area

Known occurrences of Stearns coal of minable thicknesses within the proposed reservoir area extend from the damsite upstream to the vicinity of the Kentucky-Tennessee boundary. Pomerene (3) mapped the geology of the Barthell quadrangle and part of the Oneida North quadrangle which contain the Kentucky portion of the proposed reservoir area. He stated: "Of 29 diamond-drill hole logs available from the area, none showed more than one coalbed over 30 inches thick although as many as six different coalbeds were revealed in several drill holes. Correlation of coalbeds between adjacent drill holes is generally uncertain. Drill hole data suggest that lenticular coalbeds and pods of minable thickness may occur in any position in the lower and middle part of the Beattyville Shale Member, and minable lenses near the bottom of the member have been called Stearns No. 1 as a mining convenience...."

The Stearns Coal & Lumber Company furnished data from 14 drill holes and 13 prospects which penetrated or exposed Stearns coal over a 7,450-acre block at the damsite and extending upstream (fig. 4 - 29). The Stearns No. 1 seam is present and of minable thickness (50 inches) at only one location; the Stearns No. 2 seam ranges from 13 to 51 inches (average 36 inches) at 25 locations; and the Stearns No. 3 seam ranges from 36 to 43 inches at three locations. Both the Stearns No. 2 and Stearns No. 3 seams were recorded in two drill holes, but only one of these holes showed minable thickness in both beds. The Stearns No. 1 and Stearns No. 3 seams are not considered further in this report since there are no data showing continuity. Inundation of these seams should cause no compensable damage. The nearest large-scale mining of the Stearns No. 2 coal has been along South Fork Cumberland River approximately 1/2 mile downstream of the damsite. Mining here, however, was discontinued in 1962. The closest operating mines in the Stearns No. 2 seam (fig. 4 - 29) were reported by Stearns Coal & Lumber Company to be in the Rock Creek area, a few miles northwest of the proposed damsite. Except for one small inactive mine approximately 5 miles upstream from the proposed damsite, no mining of the Stearns coal is reported within the proposed reservoir area.

Sufficient data were available to indicate continuity of the Stearns No. 2 coalbed in a block of minable extent and thickness. Mineral rights would add significantly to project costs.

2/ Underlined numbers in parentheses refer to items in the list of references at the end of this report.

Stearns coal is a high-volatile bituminous type generally containing 5 to 10 percent ash and 1 to 3 percent sulfur. It is suited for steam-plant use. A recent analysis representing 97,000 tons of coal mined from the No. 2 seam follows:

Moisture......	pct.	3.776
Ash...........	pct.	9.438
Sulfur........	pct.	2.435
B.t.u.........		12,829.7

White Oak Coal Areas

Luther (2) reported White Oak coal reserves of minable thickness in the vicinity of North White Oak Creek and the Scott-Fentress County line in Tennessee (fig. 4 - 29). Luther's unpublished reserve maps show that approximately 635 acres of the area which would be acquired for the reservoir is underlain by coal ranging in thickness from 28 to 44 inches. The area that would be acquired is regarded as that bounded by a line drawn approximately 300 feet horizontally outside the proposed flood pool. The coal seam in this area dips generally downstream and is 50 to 80 feet below the streambed. The White Oak seam has not been mined commercially in the immediate area, and economic prospects do not appear promising. However, three small inactive mines at an altitude of about 900 feet about 6-1/2 miles downstream between Bill Branch and Rough Shoal Branch may be in the lateral equivalent of the White Oak coalbed. Because coal is known to be present in minable thickness, mineral rights must be considered.

Other Coal Areas

The Wilder seam reportedly crops out in the lower part of the proposed reservoir area and goes under South Fork Cumberland River at the confluence with Pine Creek in Scott County, Tenn. There is no evidence that the seam here has ever been commercially mined or exists in minable thicknesses. Insufficient data are available to consider the seam of commercial value within the area to be acquired.

The 18-inch thick Glenmary seam has been stripped in the vicinity of Winona, Hughett, and Newton, Tenn. Nine abandoned strip mines appear to be slightly above the proposed maximum flood pool elevation but are at least partially within the area that would be acquired for the reservoir; in three cases the lower parts of the spoil banks would probably be below the flood elevation. In most places, however, the bed occurs above the area that would be acquired for the proposed reservoir. The previously mentioned strip mines are believed to be the only instances of direct conflict involving the Glenmary seam. Considering the small areal extent and thinness of this coal where it would be in conflict with the proposed reservoir and the increased thickness of overburden at most unstripped locations, it is doubtful that the value of mineral rights would add significantly to acquisition costs.

Two small railroads devoted mainly to the movement of coal and timber would be partially inundated by the reservoir. The Tennessee Railroad operates 51 miles of main line track between Oneida and Forked Mountain, Tenn. About 13 miles of track would require relocation. This railroad is presently carrying an estimated 5,000 tons of coal daily from three operations. The coal is hauled north to Oneida and then shipped mostly via Southern Railway to southern markets. The Brimstone Railroad maintains 15.8 miles of track between New River and Little Creek, Tenn., of which 10.5 miles would be adversely affected by the project. It connects with the Southern Railway at New River. The railroad in summer hauls about 1,200 tons of coal daily from five mining operations; in winter, it hauls about 350 tons daily from four operations. The coal is used primarily at steamplants in the south.

At least three abandoned oil wells are present below the proposed flood pool elevation and a fourth is near the maximum flood pool shoreline (fig. 4 - 29). Among these is the first well in Kentucky to produce oil. It was drilled for salt at the confluence of Oil Well Branch and South Fork Cumberland River in 1819 (3). There are no producing wells in the area.

Clay or shale underlying coalbeds is often "fire clay" although its suitability for such use in the general area is unproven. Pomerene (3) stated: "...underclay mined after the coal was extracted from one mine in the area reportedly was sold for fire clay for a greater sum than had been received for the coal." Sufficient data are not available to determine clay value and its effect on the cost of mineral rights.

Mississippian limestone occurs in the valley bottoms in the lower part of the proposed reservoir area. The limestone has not been mined, and value of mineral rights should not be significant.

CONCLUSIONS

Coal is the only mineral resource of significant value in the proposed Devils Jumps Reservoir area. Four old abandoned wells, some of which once produced oil, are present but insufficient data are available to assess prospects for the future. Shale underlying coal seams is called "fire clay" and at least in one location reportedly was mined for such use. No past or current mining for clay within the immediate reservoir area is known, however, and prospects for the future could not be determined. Sections of two small coal-hauling railroads would be inundated.

Two areas totaling 8,085 acres, or 10.5 percent of the 77,125 acres that would be affected by the proposed reservoir, contain coal of minable thickness.

The Bureau of Mines recommends in accordance with the agreement of February 19, 1962, between the Secretary of the Interior and the Secretary

of the Army that coal mining and other mineral activities be permitted in the affected areas, if possible, so that resources will not be lost.

Water from abandoned mines within the area should have little, if any, measurable effect on the overall quality of water in the proposed reservoir; however, higher than normal acidity and siltation can be expected in the vicinity of active or abandoned mines with drainage to the proposed reservoir. The volume of runoff from unmined areas of the watershed would considerably exceed that passing through mines and would result in a high degree of dilution.

REFERENCES

1. Huddle, J. W., E. J. Lyons, H. L. Smith, and J. C. Ferm. Coal Reserves of Eastern Kentucky. U.S. Geol. Survey Bull. 1120, 1963, 247 pp.

2. Luther, Edward T. The Coal Reserves of Tennessee. Tennessee Dept. Conservation, Div. Geol. Bull. 63, 1959, 294 pp.

3. Pomerene, Joel B. Geology of the Barthell Quadrangle and Part of the Oneida North Quadrangle, Kentucky. U.S. Geol. Survey Geologic Quadrangle Map GQ-314, 1964.

MINERAL RESOURCES
IN
THE PROPOSED PARKER BRANCH RESERVOIR AREA
CUMBERLAND RIVER BASIN, KY.

by

John W. Sweeney[1/]

ABSTRACT

An onsite examination was made in the proposed Parker Branch Reservoir area, in Rockcastle, Jackson, and Clay Counties, Ky., to determine mineral resource involvement. Some thin uneconomic coals would be flooded. Coals of economic importance in the proposed reservoir area are at altitudes that would not be affected, and most of these have been mined out. There is no active commercial coal mining in the proposed reservoir area. A commercial limestone operation would also be flooded. The quarry is on leased federal land and operated on a royalty basis.

PROPOSED WATER DEVELOPMENT PROJECT

The proposed water development project of the Corps of Engineers is on the Rockcastle River, Cumberland River Basin, in eastern Kentucky. It is proposed that a dam be constructed at the Parker Branch site at mile 49.3 above the mouth of the river. The proposed reservoir would provide hydroelectric power and recreation.

The proposed project is in the Rockcastle River watershed and has a total drainage area of 721 square miles. About one-half of this watershed is within the boundaries of the Daniel Boone National Forest. However, many acres within the National Forest are in private ownership.

The Bureau of Mines conducted a field investigation on March 22 and 23, 1967, to determine the mineral resources that would be affected in the proposed reservoir. This investigation was limited to the area encompassed at full pool altitude plus a 300-foot strip of land measured horizontally and landward of full pool level.

LOCATION

The proposed reservoir lies in Rockcastle, Jackson, and Clay Counties, Ky. The Parker Branch damsite is 49.3 miles above the river

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mouth, 1 mile above Kentucky Highway 490 bridge near Lamero, Ky., and would have either a full pool altitude of 1,050 feet or an alternative altitude of 980 feet. The water would back up north to McKee, Ky., and south beyond the Clay County line for a total backwater of over 26 miles. Figure 4 - 30 shows the proposed Parker Branch Reservoir and the location of an active limestone mining operation that would be affected.

TOPOGRAPHY AND GEOLOGY

The Rockcastle River Basin lies on the eastern side of the Cumberland Plateau province, with the river incised in a deep narrow valley. Small tributary streams severely dissect the Plateau, resulting in rugged topography. At the "Narrows" and above for a considerable distance, the river valley is particularly confined, with prominent cliffs about 100 feet high on both sides of the river. Farther upstream, the valley widens to one-half to three-quarters of a mile. Altitudes range from about 730 feet in the lower reaches of the basin to over 1,400 feet in the northern reaches of the proposed Parker Branch Reservoir. There are only small scattered areas of flood plain alluvium, and the river largely flows on bedrock.

The bedrock in the proposed reservoir area is relatively flat-lying Lower Pennsylvanian rocks consisting of sandstone and shale, with some coal. At the proposed Parker Branch damsite, the Mississippian rocks are about 100 feet below the river bed.

MINERAL RESOURCES

Coalbeds that have been mined in the proposed reservoir area are the Lily and Unnamed seams. Commercial quality coal has been mined at altitudes higher than the normal full pool in the proposed reservoir. Much of this coal has been mined out, and no active commercial coal mines are in the proposed reservoir area at the present time. Some thin uneconomic coal seams would be flooded by the reservoir. There is no record that this coal ever was mined commercially, and under present conditions it will remain uneconomic. There are numerous abandoned strip and underground coal mines in the area at higher altitudes than the normal full pool. These coal mines would not be affected, nor should they have any adverse effect on the reservoir. Water from the abandoned mines has had no known adverse effect on the streams in the area to date, but the possibility of pollution by mine drainage should be investigated before the project is implemented.

Two small abandoned limestone quarries in the proposed Parker Branch Reservoir would be flooded. The two quarries are on Kentucky Highway 89 about three miles south of McKee, Ky.

An active underground limestone mine, M. A. Walker, Inc.'s, Indian Creek mine, is about 6 miles south of McKee, Ky., on Kentucky Highway 89.

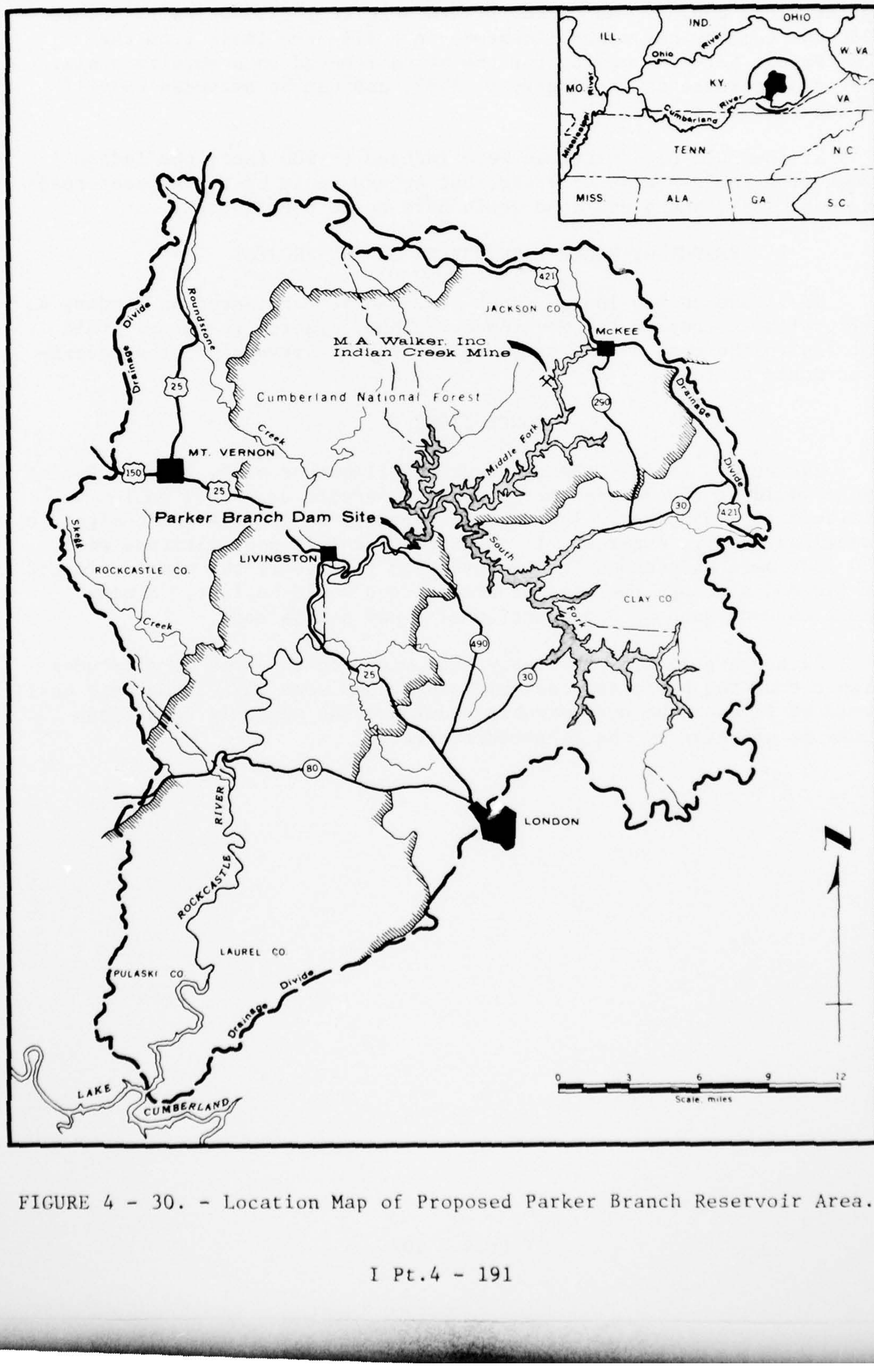

FIGURE 4 - 30. - Location Map of Proposed Parker Branch Reservoir Area.

The mine portal is at an altitude of 1,000 feet and would be inundated by the flood pool of the Parker Branch Reservoir (1,050 feet). Since 1950 the company has mined limestone on a 114-acre lease from the U.S. Forest Service, paying for the stone removed on a royalty basis. The lease terminates on January 4, 1972, and can be extended only if in the public interest.

If the full pool altitude were reduced to 980 feet, the Indian Creek mine would not be affected, but access to it by the present road would be lost, and a new road would have to be constructed.

EFFECT OF MINERAL RESOURCES ON THE PROJECT

The lease on the Indian Creek mine can be terminated on January 4, 1972, without cost to the Government. Thus, mineral resources would not add to the cost of the project, but royalty revenue to the Government would be lost.

CONCLUSIONS

The active Indian Creek underground limestone mine, on U.S. Forest land, would be flooded by the proposed reservoir at a full pool altitude of 1,050 feet. The mine is operated on a lease which might be cancelled when it expires. If the alternate full pool altitude of 980 feet were maintained for the proposed reservoir, the mine would not be flooded although the present access road would be lost. Mining could be continued by construction of a new access road.

Although coal has previously been mined in the area at altitudes higher than the proposed reservoir level, and some thin uneconomic coal would be flooded, no coal minable under present economic conditions would be affected by the proposed project.

SUBREGION J

No sites were investigated in Subregion J.

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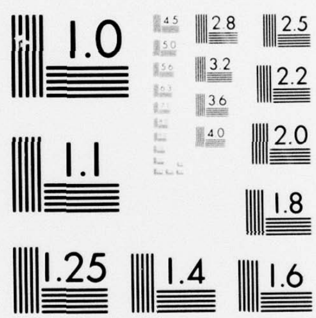

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PART 5. - DISCUSSION AND CONCLUSIONS

by

Stanley A. Feitler[1/]

The Appalachian Region contains abundant mineral resources which have been extensively developed. Many mineral commodities have been produced, but output of fossil fuels, led by bituminous coal, has had the greatest value by a wide margin. Bituminous coal from the Region has been one of the leading factors in the industrial growth of the Nation. In addition, coal exports provide a favorable and significant increment to the balance of payments in international trade.

Second in importance are the nonmetallic mineral commodities. Most of the value of production in the nonmetal group has been for construction materials which include stone, sand and gravel, clays, and cement. Some of the lime produced in the Region is used for construction, but most is consumed as a basic raw material in chemical processing.

Except for zinc, Appalachia has not been an important source of ores of metals in recent years. Metals such as iron, aluminum, and ferroalloys are produced in the Region from ores imported or mined in other parts of the United States. Zinc ores mined in Appalachia account for about one-quarter of total United States production.

Extensive reserves of most mineral commodities currently being produced, remain and will continue to be available as a mineral base for a prosperous local economy. Reserves of coal suitable for coking are adequate to supply an expanded export market in addition to domestic requirements.

Mining, particularly of coal, may have been the most important single factor contributing to the economic development of Appalachia. Although mining has not brought about a uniformly high degree of prosperity in the mining communities, it has supplied the mineral raw materials for industrial development. Most of the industrial centers in Appalachia have grown and prospered because abundant fuel and other mineral resources were nearby.

The number employed by the mining industry in Appalachia has decreased during the past 25 years. During the same period, the prices of coal and many other mineral commodities have increased at a much

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lower rate than the general trend of prices in the Nation. To remain competitive, the industry has had to improve mining methods. Modern technology has resulted in greatly increased productivity and correspondingly fewer but better paid jobs.

The physiography of much of Appalachia is not conducive to widespread industrialization. Many mining districts are in areas that are not attractive to other types of industry. As compared to a manufacturer seeking a plant site, the miner has no choice. The mine must be at the ore body and all other factors must be adapted to that environment. When a mineral deposit or a mining district is depleted or can no longer be worked profitably, it must be abandoned. When no mines are operating within commuting distance, a miner must obtain another type of job, move, or remain unemployed. Even though some mining districts have been active for generations, mobility is a necessity for mining companies and mine workers.

Water is used in processing many of the mineral commodities produced in Appalachia. Although an ample water supply is not found at all potential mine sites, the ore can usually be hauled to a plant situated near a source of water. The preparation of coal and sand and gravel accounts for most of the water used by the mineral industry in the Region because of the large tonnage treated. Preparation of other commodities such as zinc, copper, and feldspar require the use of a comparable quantity of water per ton of ore, but the tonnage of ore treated is much less.

Scarring of land, and air and water pollution are recognized as present coproducts of mining. However, a concerted effort in research and technologic development with close cooperation between industry and government can abate these negative aspects.